BEFORE THE PUBLIC UTILITIES COMMISSION
OF THE STATE OF HAWAII

In the Matter of the Application of	)	
	)	
MAUI ELECTRIC COMPANY, LIMITED	)	Docket No. 2011-0092
	)	
For Approval of Rate Increases and Revised Rate Schedules and Rules	)	

MECO
2012 TEST YEAR

Maui Electric System Improvement and Curtailment Reduction Plan

Book 2

September 3, 2013

Other Items

Introduction

In the Commission's Decision and Order No. 31288 ("D&O 31288"), the Commission also requested the Company to address "(3) Other options that MECO may have identified to accept more renewable energy or otherwise lower total system costs, such as, for example, investments at independent power producer facilities to provide increased down reserve and other ancillary services or other strategies to reduce curtailment" (D&O 31288 at 135-136). This exhibit addresses this topic.

Investments in Independent Power Producers ("IPPs") to Provide Down Reserve and Other Ancillary Services, or Other Strategies to Reduce Curtailment

The wind farms on Maui currently provide the following grid support functions as a part of their contractual commitments in their current Purchase Power Agreements ("PPA"):

- Ride-Through Requirements
  - All wind plants have similar over and under frequency and voltage ride-through requirements
- Ramp Rate Limits
  - Kaheawa Wind Power, LLC ("KWP I")
    - Upward ramp rate limit
    - Downward limit when operationally possible
  - Kaheawa Wind Power II, LLC ("KWP II")
    - Upward and downward ramp rate limits
  - Auwahi Wind Energy, LLC ("AWE")
    - Upward and downward ramp rate limits
- Dispatchable Power Reserves
  - KWP II Battery Energy Storage System ("BESS")
    - Power dispatched from BESS after reserves from Maui Electric generation is depleted
- Active Power Frequency response
  - KWP II BESS
    - Aggressive response to large over and under frequency events
    - droop response to smaller over and under frequency events
  - AWE wind turbines
    - Simulated inertial response to under frequency events
    - Droop response to over frequency events at all times and a droop response to under frequency events when curtailed below their available power capabilities
- Voltage Regulation
  - KWP I
    - Maintain voltage set point at Point Of Interconnection ("POI")
  - KWP II
    - Maintain Voltage Set Point at POI

    - AWE
        - Maintain Voltage Set Point at POI
- Down Reserves
    - KWP II
        - Utilizing the wind farms and BESS at KWP II was major point of focus of the Maui Wind Integration Study that was conducted in a partnership between Maui Electric and First Wind. The combination of the aggressive frequency response of the KWP II BESS and the innovative automatic curtailment systems implemented in the Maui Electric's Automatic Generation Control ("AGC") system enables Maui Electric to reduce the down reserves it requires on one of its dual train combined cycle generators based on the findings and recommendations of the study

Now that all three wind plants have been in service since the end of 2012 and Maui Electric has implemented additional operating measures to reduce renewable energy curtailment, and is considering additional measures discussed in this filing, Maui Electric has engaged in preliminary discussions with First Wind (the majority owners of KWP I and KWP II) and AWE to exchange ideas on further optimizing the use of the wind farm facilities, including the battery systems.

The intent of those discussions, and the analysis that will likely be needed following those discussions, is to take a holistic approach to the use of the facilities that have been installed on Maui to support renewable energy integration and system operations for the Maui power system.

The steps that will likely be needed to develop feasible options and characterize the benefits of those options include:

1. Reviewing the operational changes proposed in this filing and the resulting operating modes at different load levels to determine the more challenging times for the system in terms of curtailment and system stability;
2. Review the operating history of the wind farms in terms of variability and production to determine if they are at similar levels that were assumed in the modeled wind data used in previous studies;
3. Assess the impacts of the operating practices that are being proposed, assuming existing BESS control functions and confirmed wind power characteristics, on issues such as:
    a. Reserve requirements;
    b. AGC Frequency control and its ability to meet proposed CP 1 and CP 2 frequency control standards;
    c. Frequency response to contingency events such as transmission faults, line outages and generation trip events;
    d. System steady state power flow Volt/VAR analysis assuming line and unit outages;
    e. Voltage recovery following transient events;
    f. Short circuit ratio assessment (wind turbines have minimum requirements for control stability); and

   g. Available fault current and protection;
4. After understanding the system needs, determine the potential options for, and value of, changing the operational requirements of the wind farm and their battery systems, as well as utility assets, to address the system issues or constraints that were identified; and
5. Finally consider the potential options for, and value of, making investments in wind farm facilities and/or utility assets to address the system issues or constraints that were identified.

The time and expense that will be needed to conduct these assessments and determine and negotiate changes to the wind plant assets and PPA's will depend on the issues and scenarios that need to be assessed. One point of reference is the Maui Wind Integration Study where the study was initiated in the January of 2009 timeframe and the final report was completed in June of 2010. The KWP II PPA was executed in September of 2010 (negotiations were taking place in parallel to the study work). The costs associated with these types of studies are typically on the order of several hundred thousand dollars. The exact cost of the Maui wind study is considered proprietary by the consultant who conducted the study. The time and cost for this analysis maybe significantly reduced due to the availability of actual wind production data; however, time and expenses may also be added if more detailed analysis is required for some of the issues that were not a concern in the scenarios assumed in the Maui Wind Integration Study.

In conjunction with the above proposed discussions with the IPPs, Maui Electric would like to reexamine the energy prices contained within certain PPAs. Maui Electric has made significant progress to date in reducing curtailment and, as this plan demonstrates, has plans to enact further curtailment reductions. As a result, at some point in time, Maui Electric would like to explore if certain IPPs that will benefit from the reduction in curtailments of renewable energy on Maui's system are willing to revisit the pricing terms in their PPAs as some of the assumptions under which those PPA terms were developed (e.g., amount of curtailment) have changed. This could result in a win-win situation for the IPP and Maui Electric customers – additional energy purchased from an IPP, which would increase the IPPs revenue stream even with a lower pricing structure, while the lower pricing structure could result in lower energy payments (and lower energy charges passed on to Maui Electric's customers) even with the increased amount of renewable energy purchased.

Additionally, Maui Electric from time to time receives unsolicited proposals from third parties on non-utility generation projects. Maui Electric will continue to review these proposals with the objective of exceeding the RPS targets, reducing curtailment, and lowering customer's bills.

<u>Future Development and Utilization of Distributed Energy Resources on Maui</u>

The Japan U.S. Maui Project/Smart Maui ("JUMP Smart") project will develop and demonstrate the use of smart grid technologies to enhance island electric power system operations and performance. This includes the capability to integrate distributed and central station renewable energy, Electric Vehicle's ("EV"), and controllable loads into the electric power system. Maui Electric and Hawaiian Electric worked with the New Energy and Industrial Technology Development Organization ("NEDO") from Japan to develop project objectives and executed a non-binding

Memorandum of Understanding ("MOU") with the State of Hawaii Department of Business, Economic Development and Tourism ("DBEDT"), County of Maui, Maui Economic Development Board, and Hawaiian Natural Energy Institute ("HNEI") to support the implementation of the project. The project will seek to improve the following range of power system issues:

- Excess energy;
- Supporting EV adoption, via the installation of a quick charging network, to utilize excess renewable energy to displace transportation fossil fuels;
- Utilizing demand response for circuit and system level issues via the Distribution Management System ("DMS"), Micro-DMS, and an in-home gateway;
- Power Quality via voltage monitoring and Smart Inverters;
- High levels of EV charging;
- Use as a resource to manage local and system variability;
- Manage charging to manage circuit and transformer overloads;
- Feeder load monitoring and response;
- Enhance operator visibility;
- Minimize operator intervention;
- Customer engagement;
- Customer acceptance and feedback;
- Communications infrastructure; and
- Cyber Security.

The JUMP Smart project is being funded primarily by Japan's NEDO, who will be utilizing approximately $30 million (at the current exchange rate), in funding provided by Japan's Ministry of Economy, Trade and Industry. The United States Department of Energy ("DOE") is supporting the project by providing access to their experts at three of their national laboratories (National Renewable Energy Lab ("NREL"), Sandia National Lab, and the Pacific Northwest National Lab ("PNL") and by providing the means for network system collaboration between the DOE Renewable and Distributed Systems Integration ("RDSI") Maui Smart Grid Project in Wailea and the Smart Grid Demonstration Project in Kihei.

The objective of the JUMP Smart project is to: (1) provide a stable supply of electric power to customers through enhanced grid operability and reliability in an islanded high penetration wind and solar power environment, (2) explore the capability to maximize the utilization of renewable energy on Maui, (3) provide a solution for the possible high penetration of electric vehicles on the future Maui power grid, and (4) leverage external resources to test new smart grid technologies and concepts in Hawaii and demonstrate their operation to other islanded grids around the world.

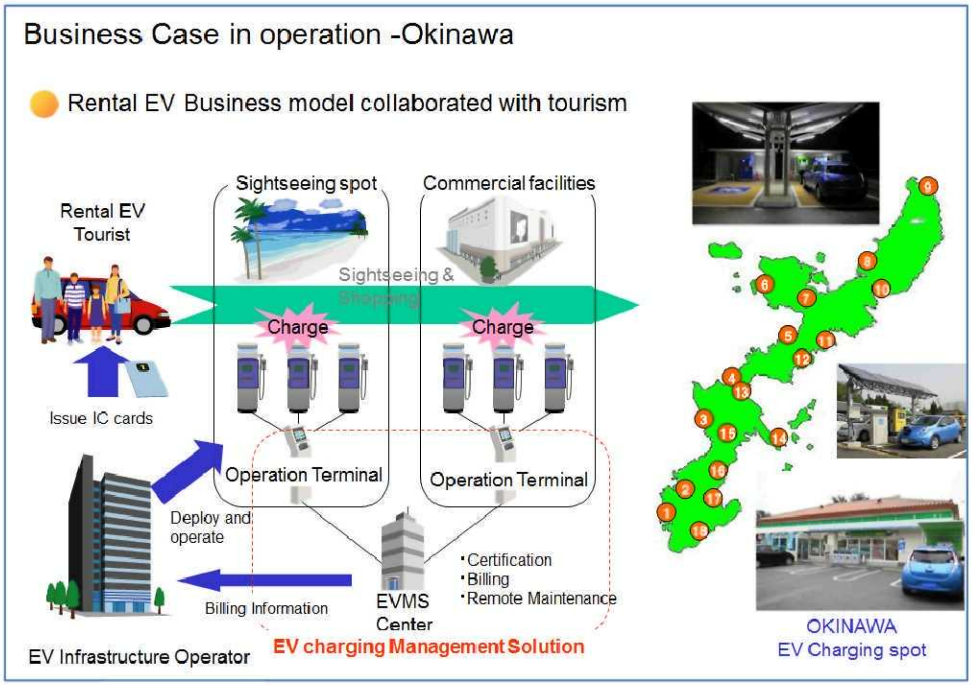
The project will concentrate in the Kihei area of South Maui, and will consist of the following:

- An Electric Vehicle Energy Control Center ("EVECC"), installed at the Maui Electric's Data Center that will monitor and control a network of charging stations throughout the island of Maui. The EVECC will also communicate with the network operation centers of the EV manufacturers to obtain charging forecasts for the utility and to provide excess energy forecasts to the manufacturers to help the vehicles to utilize excess renewable energy when available.

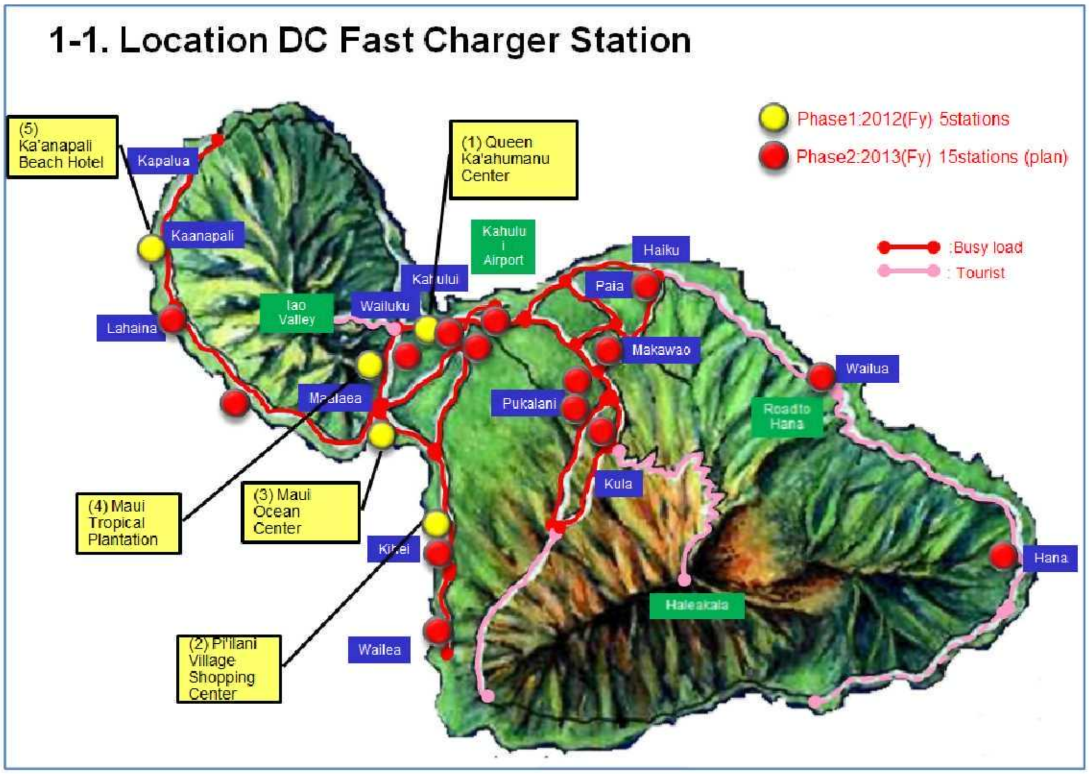
- Battery storage systems will be installed in the Kihei area and a Maui College to mimic EV charging load since the number of electric vehicles in the project area will not be sufficient during the demonstration period.
- A Static Var Compensator ("SVC") will be installed to demonstrate the management of voltage fluctuations using a single unit rather through distributed control.
- Twenty EV Quick Chargers will be installed in strategic public areas to support the adoption of EV's throughout Maui. Quick Chargers can fully charge electric vehicles in about 30 minutes.
- Micro-DMS's will be installed in Kihei and at quick charging stations installed by AEC Hawaii at distribution transformers that feed individual homes and the quick chargers. The micro-DMS will monitor the transformers for any overloads and utilize voltage information from the smart meters to monitor voltage levels. It will also control community storage systems, load control devices, smart PV inverters, and EV charging to address any overload or voltage issues at the service voltage level.
- A DMS will be installed in Maui Electric's Data Center that will monitor and develop control solutions for the distribution circuits in the Kihei area. The DMS will be able to utilize the resources under the micro-DMS's control to address issues at the higher voltage distribution circuits if the micro-DMS allows it to do so (i.e., there are no lower voltage issues being mitigated by those resources). The DMS will also provide information to the system operators on the current load under its control that can be used to meet system level reserve requirements.
- Level 2 EV chargers will be installed in volunteer premises. The level 2 EV chargers will monitor the load and voltage.
- A Smart Meter will be installed at volunteers homes and will communicate voltage and load profile information back to the DMS. This information will be analyzed by the DMS and micro-DMS to manage power variability, perform demand response functions, and eliminate overload and over voltage at distribution transformer and customer services. Smart meters will also be installed on home charging stations around the island where EV owners volunteer to participate.
- A Medium Voltage Section Switch will be installed to monitor current and voltage on the various project circuits.
- A Home Gateway and Load Control Switch will be installed in volunteer homes to monitor load and issue demand control functions from the DMS and micro-DMS.
- A Smart PV Inverter will be installed at volunteer homes for enhanced communications and control of the PV resource. The Smart PV Inverter will be able to mitigate voltage fluctuations and provide grid integrity.

<u>EV Growth Strategy</u>

The project is working with rental agencies to promote the use of EVs in their rental fleets that could utilize the quick charging stations. It is also working with EV car dealerships to promote the use of the quick charging network to reduce range anxiety for local EV users. Mizuho Bank, one of the partners on this project, is developing the business case for the project and also working on an Eco Tourism strategy with Japan travel agencies. This vision is to have rental fleets bring in EVs for use by tourists who are interested in a more environmentally friendly alternative and then after a few years, those EVs could be sold to local residents as used cars and new cars would be brought on island for the refresh the rental fleets. The strategy was borrowed from Okinawa, who currently has a network of quick charging stations and an active EV rental business. See the figure below that shows the location of the charging stations (more have been added) and the Rental EV Business model.



The JUMP Smart project will install 20 quick charging stations throughout Maui which are essential to support an EV rental business model and which will also help reduce any range anxiety that may cause a potential local EV buyer to hesitate purchasing an EV. See the figure below for the five phase 1 locations where the installations have begun or have been completed and the potential locations for the other 15 stations that are part of the phase 2 deployment.



<u>Further Development after the JUMP Smart Project</u>

The JUMP Smart project is currently in its initial deployment stage and some of the infrastructure has been put in place like the Quick Charging stations as well as the DMS and the EVECC. While the team is working on the deployment, discussions are already taking place on the next phase of the project. This next phase will focus on the development of use of the energy resources being used in the JUMP Smart project as well as the introduce new technologies such as EVs that can also export energy using what is being call Vehicle to Grid ("V2G") or Vehicle to Home technologies. These new types of vehicles can be used to not only control their charging to support grid issues, but also be used in times of emergency to power critical loads within the home such as lights and refrigerators, especially if the home owner also has PV energy available during the day.

These new vehicles, in conjunction with other distributed resources, may be able to work together to form a dispatchable resource that can provide energy when needed like a virtual power plant ("VPP") on the system. With this new project and partnering with V2G vehicle manufacturers, the level of EV utilization can be further increased on Maui thereby utilizing more renewable energy and displacing fossil fuel usage not only for electricity generation, but also for transportation. The use of electricity as a substitute for gasoline has the added benefit of broadening the rate base while saving the driver money on the energy that is use for transportation.

The discussion on this project concept are in their preliminary stages and are currently only at the conceptual level. Many more details need to be worked out before commitments can be made to move forward with the project. Attachment K1 contains a presentation developed by Hitachi to describe the high level concept of the VPP project.

Other Energy Storage Efforts

Maui Electric has evaluated the potential for pumped storage hydro ("PSH") projects on Maui several times in the past to help with the integration of renewable energy (see Attachment K2 for a detailed summary). To date, none of the analysis done - spanning almost 20 years and performed by multiple consultants - has provided a compelling case for the use of PSH. Maui Electric will continue to evaluate the possibility of a PSH project as new information becomes available.

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DRAFT

Generic Description - VPP

July 31, 2013

Contents

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1. Background

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- At present, the Maui power system has a high penetration of Renewable Energy (RE), especially distributed Photovoltaic (PV) installations have been growing at an exponential rate for several years now, and now in total is equal or greater than Maui Electric's firm generators. However, PV, unlike firm generation, is intermittent and fluctuating in nature.
- The existing demonstration project is currently underway, focusing on enabling high levels of distributed PV and EV on Maui and demand side management including EV charging and to utilize excess energy and charge management to control manage frequency and RE fluctuations. This demonstration will be implemented using EV quick chargers as well as EV and water heating in Home Residences.
- While the current efforts are on-going, the cost of imported oil for electricity and transportation in Hawaii remains quite high. Therefore, in order to mitigate these concerns, a more advanced and scaled-up solution and technology deployment is required.

Need more reliable and efficient solution

2. Framework for Enhanced Demonstration

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An Enhanced demonstration project offers to incorporate and manage renewable energy and electric vehicles to achieve a clean future for Maui County.

The aim is to demonstrate, analyze and enhance the integration of energy systems for Maui in order to contribute more renewable and more cost efficient solutions. Relevant features of the enhanced project can be summarized as follows:

- Supports the Virtual Power Plant (VPP) - coordinated and remote "clustered control" of multiple Distributed Energy Resources (DER), and aggregates potential distributed energy resources, makes this available as reliable a resource to balance between supply and demand by (DR) Demand Response
- Supports the V2G (Vehicle to Grid) - charge/discharge functionality due to stable and maximized usage of renewable energy with combining RE and EV storage
- Supports the EV charging infrastructure - further dissemination and deployment of charging infrastructure to support a mobility solution for higher EV penetration

Objective of VPP in Maui

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The overall objective is to demonstration the ability of Hitachi VPP solution for effective integration of renewable energy source and supporting the system services for the grid stability and safety by balance peak demand, and supply through controlling peak demand in an economically more effective way.

Proposed VPP consists of three (3) sub-groups of aggregated energy resources.

- Domestic VPP
- EV VPP
- Battery VPP

4. VPP High-Level Conceptual Architecture

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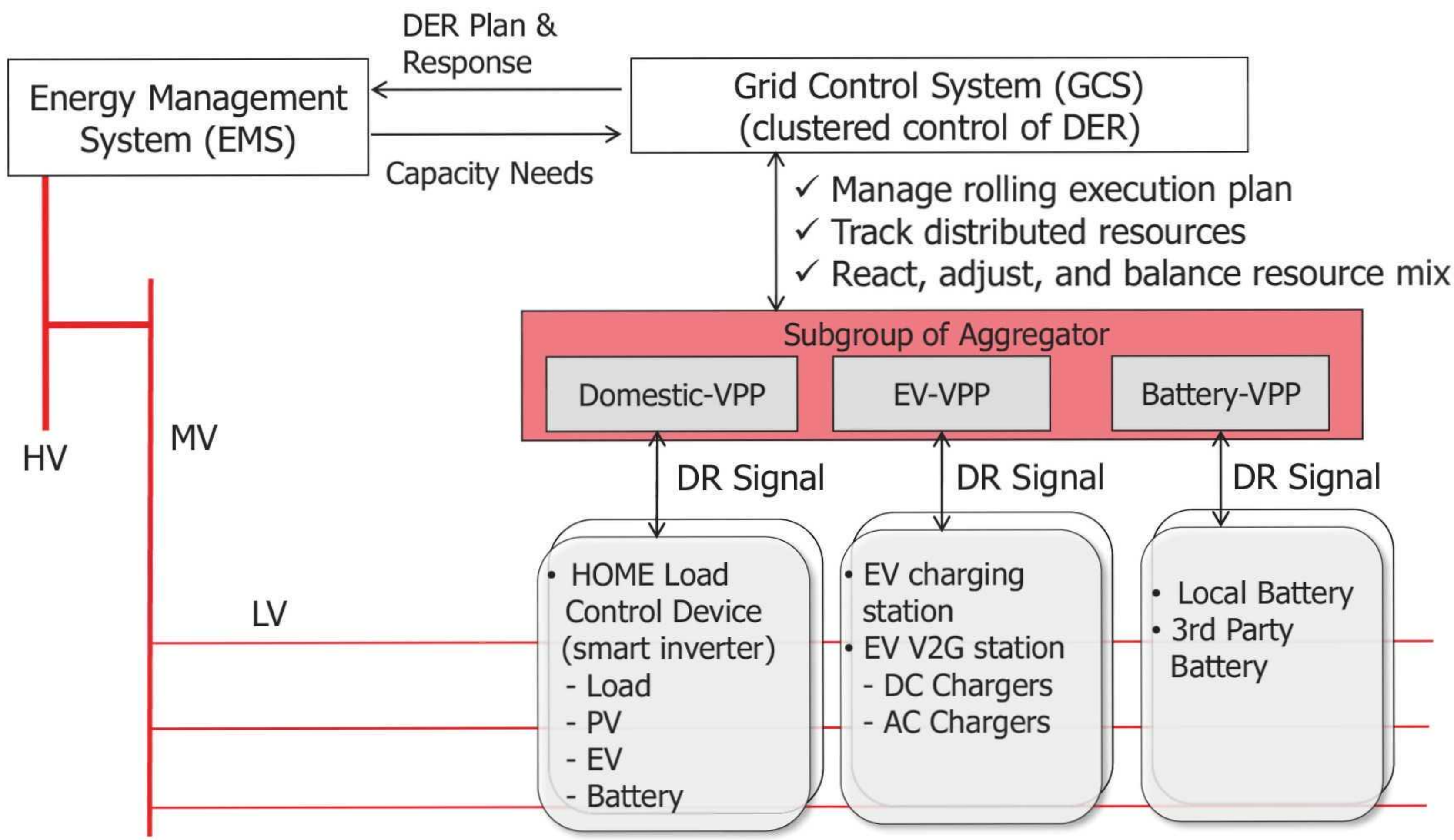

5. Main Systems

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- Grid Control System (GCS) aggregates distributed energy resources (DER such as home load control device, storage and EV, etc.) and make this available as a controllable resource that coordinates with the existing EMS.
- "Domestic-VPP" aggregates home load control devices, makes this available as a controllable resource, and dispatches DR signals to local devices in response to power requests from GCS.
- "EV-VPP" aggregates EV storage resources, makes this available as a controllable resource, and orchestrates charge/discharge in response to guidance from GCS.
- "Battery-VPP" aggregates storage resources, makes this available as a controllable resource, and orchestrates charge/discharge in response to guidance from GCS.

6. Conceptual Framework for VPP

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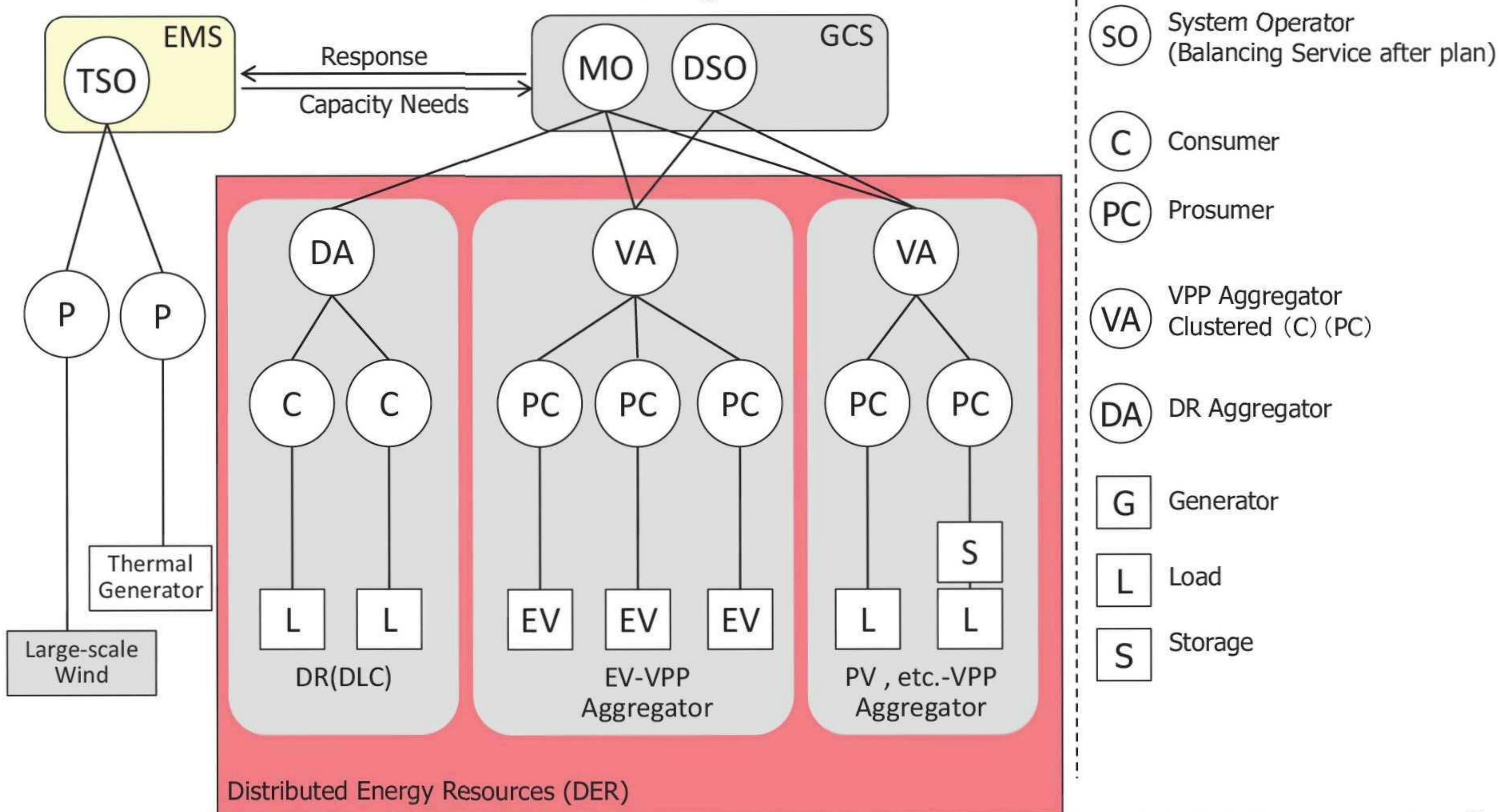
- The virtual power plant consists of the several dispersed controllable production or consumption units through the advanced schedule and forecast algorithms.



Abbreviations

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D

DER : Distributed Energy Resources
DR : Demand Response

E

EMS : Energy Management System
EV : Electric Vehicle

G

GCS : Grid Control System

P

PV : Photovoltaic

R

RE : Renewable Energy

V

V2G : Vehicle to Grid
VPP : Virtual Power Plant

Summary of Maui Electric's Pumped Storage Hydroelectric Generation Activities

Background

Maui Electric has investigated the use of pumped storage hydroelectric ("PSH") generation technology for the Maui grid for almost twenty years. Maui Electric realized early on that energy storage technology had the potential to increase the amount of renewable energy that an isolated island grid can accept and that PSH has the advantage of being the only proven and commercially available large-scale energy storage technology. In 1995, Christensen and Associates completed a Hydroelectric Pumped-Storage Study as part of Maui Electric's IRP-2000 effort. As the issue of higher penetration of intermittent as-available renewable energy became more pressing and the details of its impact became better understood, Maui Electric's investigation of PSH evolved to improve the analysis of the potential benefits. Issues beyond the typical increasing of system minimum load to accept more renewable energy and the price difference between off-peak and on-peak energy were investigated. These included the provision of operating reserve and system frequency regulation. However, all of the analysis to date have indicated that PSH technology is not cost-effective compared to other resources even under a range of planning assumptions.

Christensen & Associates

As part of its IRP-2000 process, Maui Electric retained Christensen & Associates to develop cost and performance data for potential PSH sites on the island of Maui. Maui Electric then analyzed PSH as a potential future generation resource on its Maui grid in its IRP-2000 process. Specifically, Maui Electric looked at the increase in system minimum load which would allow more wind energy to be accepted and the off-peak/on-peak energy price differential. The PSH characteristics based on the Christensen & Associates study were shown on page 121 in Appendix I of the IRP-2000 report.[1] The resource plan F-28 on page 8-13 of the IRP-2000 report included PSH and wind resources. The analysis of PSH was explained on page 7-15 of the IRP-2000 report and the finding that PSH was not cost-effective was explained on pages 9-23 to 9-24 of the IRP-2000 report.

MWH

From 2006 to 2008, Maui Electric retained the consulting firm of MWH to investigate the feasibility of several potential PSH sites and the use of the relatively new variable speed PSH technology. MWH included a description of the operating characteristics of variable speed PSH technology which would allow it to provide ancillary services to the Maui grid. The MWH site feasibility analysis was not ready in time for use in Maui Electric's IRP-3 planning process, however, the description of the potential benefits of variable speed PSH over conventional PSH and the potential ancillary services were explained starting on page 9-26 of the IRP-3 Plan.[2] The analysis of PSH that was performed was explained on page 7-21 of the IRP-3 Plan. The resource plan with PSH that was analyzed was shown on page 8-15 of the IRP-Plan with explanation of the analysis on page 8-16. The Pumped-Storage Hydroelectric Project Study – Report on the

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[1] Maui Electric's 2000 IRP plan for the 21-year planning horizon of 2000-2020 was filed on May 31, 2000, in Docket No. 99-0004.

[2] Maui Electric's IRP-3 Plan for the 20-year planning horizon of 2007-2026 was filed on April 30, 2007, in Docket No. 04-0077.

Maui Project and the Pumped-Storage Hydroelectric Project Appraisal Study – Report on the Maui Project, prepared by MWH, is provided as Attachment K3.[3]

Cedric Chong & Associates
In 2007, Cedric Chong & Associates investigated for Maui Electric the feasibility of in-line pumped storage hydro projects using existing potable and irrigation water systems on the island of Maui and Molokai. These potential projects would modify the existing water system to include hydroelectric generation such that electricity would be generated when the water is drawn down from the reservoir. The study concluded that several potential sites might be feasible. It is up to the owners of these water systems to determine whether to pursue these projects.

[redacted]

Other PSH Study
Most recently in 2012, Maui Electric relooked at potential PSH projects. This effort looked at the possibility that alternate configuration PSH projects might have lower associated costs. Several possible PSH sites on Maui were considered and two sites were studied in detail. The analysis concluded that alternate configuration PSH was not cost effective and did not have an apparent cost advantage over more traditional PSH projects.

Conclusion
Based on the results of the various PSH studies mentioned above and the potential for an undersea cable between Maui and Oahu to eliminate the curtailment of wind energy on the Maui Electric grid, Maui Electric decided to suspend its effort to pursue a PSH project. Maui Electric will continue to evaluate the possibility of a PSH project as new information becomes available.

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[3] Attachment K2, page 2, Attachment K3 and Attachment K4 contain confidential research and vendor information. Public disclosure of this information could negatively impact the Company's negotiating position relative to existing or potential vendors. Therefore, the Company is providing the confidential information subject to the Protective Order approved in this proceeding on August 4, 2011.

Confidential Information Deleted
Pursuant To Protective Order,
Filed on August 4, 2011.

EXHIBIT K
ATTACHMENTS K3-K4

Attachments K3 and K4 contain confidential information and are provided subject to the Protective Order filed in this proceeding on August 4, 2011.

Results of Evaluation of Potential Curtailment Reduction Measures

A. Introduction

Exhibit C of this filing:

- described the candidate curtailment reduction measures Maui Electric considered;
- described the methodology used to estimate the extent to which the candidate curtailment mitigation measures can reduce curtailment;
- described the methodology used to estimate the costs and benefits of implementing each candidate curtailment mitigation measure; and
- described the inputs used in the curtailment reduction evaluation.

The results of, and conclusions from, the analysis described in Exhibit C are provided in this Exhibit L.

Twenty two cases (as described in Exhibit C) were examined to determine the extent to which candidate measures could reduce curtailment and to determine how implementation of those candidate measures would impact system costs. Exhibit C and Attachment C10 provide a description of the assumptions used in the different simulations. The financial evaluation is represented in terms of revenue requirements. Total revenue requirements for the 25-year analysis period (2014 to 2038) contained in this exhibit are in net present value 2014 dollars. Revenue requirements in individual years are in nominal dollars.

The summary tables provided herein show year-by-year results in the 2014 to 2020 timeframe as well as the total amounts over the period 2014 to 2038. The purpose of showing year-by-year results in the 2014 to 2020 timeframe is that this period contains the most differentiation between the cases examined. Beyond 2020, there is a fair amount of commonality among the cases so that there is not as much difference among the cases as in the early years of the study period.

B. Comparison of Case Results

Attachment L1 of this Exhibit contains the case comparison tables of year over year results for revenue requirements, heat rate, fuel consumption, wind and Feed-In Tariff ("FIT") Tier 3 ("FIT3") energy accepted, and wind and FIT3 energy curtailed. Attachment L1 also contains the case comparison tables and graphs of the total results over the entire 25-year period for net present value, wind and FIT3 energy accepted, and wind and FIT3 energy curtailed. Tables showing the case rankings based on net present value and as-available energy curtailment are also provided.

C. Case Results

Attachment L2 of this Exhibit contains the results of each case.

D. Case by Case Comparison

This section compares the results on a case by case basis. The comparisons show the progression of the system and operational changes Maui Electric has implemented from the period before the Maui Operating Measures ("MOMs"), to implementing the MOMs (which were completed in July 2013), to the measures implemented or soon to be implemented as explained in Maui Electric's Motion for Partial Reconsideration ("MFPR") in Docket No. 2011-0092. The system and operational changes have been implemented by Maui Electric as a means to increase renewable energy accepted on the Maui system and reduce curtailment of as-available resources. Maui Electric continues to explore additional measures to further increase the acceptance of renewable energy on Maui. The Reference Case represents the additional measures that Maui Electric can implement (deactivation of K1 and K2 and Hawaii Solar Integration Study ("HSIS") reserve requirement) in the near future and served as the baseline case against which all other cases were measured against for revenue requirements, curtailment reduction, and system efficiency. The revenue requirements reflect the impact of the various measures on fuel expense, purchased power expense, operations and maintenance expenses and capital costs and therefore reflects the cost impacts of changes in curtailment, heat rates and other effects, to the extent the Company was able to quantify such impacts in dollars. As explained in Exhibit C, the measures that are being examined have the potential to reduce curtailment and/or customer costs. The case comparisons against the Reference Case provide the insight as to which measures are promising and which measures will require further investigation.

A summary table of the case by case comparisons with respect to the Reference Case is provided in Table L226 of Attachment L1. Values in Table L226 are in net present value 2014 dollars for the 25-year planning period.

1. Pre-MOMs vs. MOMs

This comparison shows the reduction in curtailment resulting from the implementation of the MOMs. These measures, which were specified in the Kaheawa Wind Power II, LLC ("KWP II") PPA, have already been completed, and include:

- K1 and K2 scheduled operation (i.e., alternating days; one shift only).

- Implemented a minimum regulating up reserve of 6 MW or 50% of the first 30 MW of wind and 100% for next 30 MW of wind up to maximum of 50 MW regulating reserve. This has been in place since 2008.

- Allocated regulating up reserve to the KWP II battery energy storage system ("BESS").

- Implemented automatic generation control ("AGC") modifications to control as-available curtailment.

- Allocated regulating down reserve to KWP II BESS.

The effects of these measures can be seen by comparing the Pre-MOMs and MOMs simulation results to each other. Overall, between the years of 2014-2038, curtailment is projected to be reduced by 328.1 GWh. This is approximately a 40% reduction in curtailment over the Pre-MOMs case in those years. The MOMs brought about the greatest reduction in curtailment during the years before 2019 among all the cases. The up and down reserve allocated to the KWP BESS is the major contributor to the curtailment reduction.

Table L160 Curtailment Pre-MOMS VS. MOMS

Analysis Period	Pre-MOMS Curtailment (GWH)	MOMS Curtailment (GWH)	Curtailment Difference (GWH)	Curtailment Difference Percent
2014	88.7	59.0	-29.7	-33.45%
2015	85.4	55.5	-29.9	-34.99%
2016	90.2	59.1	-31.1	-34.51%
2017	85.5	54.3	-31.3	-36.55%
2018	66.2	39.2	-27.0	-40.74%
2019	24.1	12.1	-12.0	-49.77%
2020	19.7	10.4	-9.3	-47.38%
Total 2014-2038	792.8	464.8	-328.1	-41.38%

The estimated revenue requirement savings on a net present value basis over the 25-year period associated with implementing the MOMs was approximately $26.5 million coming from fuel savings at the Kahului Power Plant ("KPP"). This includes the offsetting effect of higher purchased energy expense resulting from reduced curtailment.

Table L161 Revenue Requirements Pre-MOMS VS. MOMS

Analysis Period	Pre-MOMS Revenue Requirement ($ '000)	MOMS Revenue Requirement ($ '000)	Revenue Requirement Difference ($ '000)	Percent
2014	$285,946	$284,058	-$1,888	-0.66%
2015	$286,436	$284,354	-$2,082	-0.73%
2016	$291,793	$289,744	-$2,049	-0.70%
2017	$301,193	$298,518	-$2,675	-0.89%
2018	$325,636	$322,761	-$2,875	-0.88%
2019	$347,285	$345,246	-$2,039	-0.59%
2020	$362,103	$360,123	-$1,980	-0.55%
NPV 2014-2038	$4,030,678	$4,004,204	-$26,474	-0.66%

The Maui Electric overall heat rate decreases with the implementation of the MOMs during the period when KPP is still active. Reducing the operation of K1 and K2 helps to reduce the KPP heat rate from 2014-2018. The BESS at KWP II helps to reduce the heat rate of Maalaea Power Plant ("MPP") by carrying some of the regulating reserve, requiring less Maui Electric generating units to be committed on the system. Reducing the down reserve carried by the first dual-train causes a slight increase in heat rate at MPP starting in 2019.

Table L162 MECO Overall Heat Rate Pre-MOMS VS. MOMS

Analysis Period	Pre-MOMS Heat Rate (Btu/kWh)	MOMS Heat Rate (Btu/kWh)	Heat Rate Difference (Btu/kWh)	Percent
2014	10,423	10,234	-188	-1.81%
2015	10,416	10,234	-182	-1.75%
2016	10,416	10,235	-182	-1.74%
2017	10,435	10,257	-178	-1.71%
2018	10,371	10,196	-175	-1.69%
2019	9,253	9,260	8	0.08%
2020	9,260	9,262	3	0.03%

2. MOMs vs. Motion for Partial Reconsideration

A comparison of the MOMs and the MFPR cases shows the curtailment reduction impact resulting from the measures initiated and implemented by Maui Electric prior to June 2013 and after the MOMs were implemented.[1] Those measures include:

- Reduction of the minimum loads on KPP units K3 and K4 to approximately 3.5 MW each.

[1] Most of the MOMs were implemented by December 2010. Therefore, much of the curtailment reduction benefits from the MOMs were being received since then. In June 2013, the software issues that were preventing M14 and M16 from automatically adjusting their economic minimum when the KWP II BESS was able to provide regulating reserve regulating reserve down were resolved.

- The inclusion of units K3 and K4 and MPP units M15 and M18 into the reserve contribution.

The reduction in curtailment is approximately 141.7 GWh between the years of 2014-2038. The associated measures taken in this case brought about the second largest reduction in curtailment during the years before 2019 among the cases analyzed. Additionally, all the measures in the MFPR case have been fully implemented prior to the submittal of this curtailment reduction plan. The only case with measures resulting in greater reduction in curtailment is the MOMs case.

Table L163 Curtailment MOMS VS. MFPR

Analysis Period	MOMS Curtailment (GWH)	MFPR Curtailment (GWH)	Curtailment Difference (GWH)	Curtailment Difference Percent
2014	59.0	29.0	-30.1	-50.95%
2015	55.5	25.8	-29.7	-53.50%
2016	59.1	28.7	-30.4	-51.43%
2017	54.3	25.7	-28.5	-52.56%
2018	39.2	18.3	-20.9	-53.34%
2019	12.1	11.8	-0.4	-2.92%
2020	10.4	10.3	-0.1	-0.97%
Total 2014-2038	464.8	323.0	-141.7	-30.50%

The revenue requirement savings associated with implementing the measures described above is approximately $3.6 million on a net present value basis over the 25-year planning period, coming from fuel savings.

Table L164 Revenue Requirements MOMS VS. MFPR

Analysis Period	MOMS Revenue Requirement ($ '000)	MFPR Revenue Requirement ($ '000)	Revenue Requirement Difference ($ '000)	Revenue Requirement Difference Percent
2014	$284,058	$283,479	-$579	-0.20%
2015	$284,354	$283,743	-$612	-0.22%
2016	$289,744	$288,958	-$786	-0.27%
2017	$298,518	$297,533	-$984	-0.33%
2018	$322,761	$321,219	-$1,542	-0.48%
2019	$345,246	$345,192	-$54	-0.02%
2020	$360,123	$360,108	-$15	0.00%
NPV 2014-2038	$4,004,204	$4,000,588	-$3,615	-0.09%

The Maui Electric overall heat rate further decreases after implementing the measures contained in the MFPR. The heat rate at KPP increases as K3 and K4 operate at lower levels. The contribution towards regulating reserve from K3 and K4, however, allows MPP to commit fewer units for regulating reserve and allows the committed units to operate more efficiently reducing the MPP heat rate.

Table L165 MECO Overall Heat Rate MOMS VS. MFPR

	MOMS	MFPR	Heat Rate Difference	
Analysis Period	Heat Rate (Btu/kWh)	Heat Rate (Btu/kWh)	(Btu/kWh)	Percent
2014	10,234	10,088	-146	-1.43%
2015	10,234	10,078	-156	-1.52%
2016	10,235	10,094	-141	-1.38%
2017	10,257	10,107	-150	-1.46%
2018	10,196	10,032	-163	-1.60%
2019	9,260	9,261	1	0.01%
2020	9,262	9,263	0	0.00%

3. Motion for Partial Reconsideration vs. Reference Case

Comparing the MFPR case to the Reference Case provides the estimated reduction in curtailment from two sources – the deactivation of the KPP units K1 and K2 in 2014 and the adoption of the HSIS upward regulating reserve requirements. The deactivation of K1 and K2 only has an effect until 2019, when the entire plant will be retired. The total curtailment reduction is 29.0 GWh. Of this amount, 13.7 GWh occurs in 2014-2018, prior to the retirement of KPP.

Table L166 Curtailment MFPR VS. Reference Case

	MFPR	Reference Case	Curtailment Difference	
Analysis Period	Curtailment (GWH)	Curtailment (GWH)	(GWH)	Percent
2014	29.0	25.7	-3.2	-11.08%
2015	25.8	24.1	-1.7	-6.63%
2016	28.7	24.1	-4.6	-15.93%
2017	25.7	22.7	-3.1	-11.92%
2018	18.3	17.2	-1.1	-6.23%
2019	11.8	10.6	-1.1	-9.43%
2020	10.3	10.0	-0.3	-2.85%
Total 2014-2038	323.0	294.1	-29.0	-8.97%

The revenue requirement savings associated with the deactivation of the KPP units K1 and K2 in 2014 and the adoption of the HSIS reserve requirements are approximately $4.3 million on a net present value basis over the 25-year planning period.

Table L167 Revenue Requirements MFPR VS. Reference Case

Analysis Period	MFPR Revenue Requirement ($ '000)	Reference Case Revenue Requirement ($ '000)	Revenue Requirement Difference ($ '000)	Percent
2014	$283,479	$283,171	-$308	-0.11%
2015	$283,743	$283,470	-$272	-0.10%
2016	$288,958	$288,534	-$424	-0.15%
2017	$297,533	$296,960	-$573	-0.19%
2018	$321,219	$320,252	-$967	-0.30%
2019	$345,192	$344,809	-$383	-0.11%
2020	$360,108	$359,935	-$173	-0.05%
NPV 2014-2038	$4,000,588	$3,996,263	-$4,325	-0.11%

Deactivating K1 and K2 in addition to adopting the HSIS regulating reserve criteria would potentially require fewer units to provide regulating reserve, thereby decreasing the Maui Electric overall heat rate.

Table L168 MECO Overall Heat Rate MFPR VS. Reference Case

Analysis Period	MFPR Heat Rate (Btu/kWh)	Reference Case Heat Rate (Btu/kWh)	Heat Rate Difference (Btu/kWh)	Percent
2014	10,088	10,002	-86	-0.85%
2015	10,078	10,002	-76	-0.75%
2016	10,094	10,027	-66	-0.66%
2017	10,107	10,028	-79	-0.78%
2018	10,032	9,949	-83	-0.83%
2019	9,261	9,254	-7	-0.08%
2020	9,263	9,257	-5	-0.06%

4. Reference Case vs. Case 1

The Reference Case compared to Case 1 shows the estimated increase in curtailment that results if K1 and K2 continue to operate from 2014 to 2018. This action has an effect only prior to 2019, since the entire plant is planned to be retired in 2019.

Table L169 Curtailment Reference Case VS. Case 1

Analysis Period	Reference Case Curtailment (GWH)	Case 1 Curtailment (GWH)	Curtailment Difference (GWH)	Percent
2014	25.7	26.1	0.4	1.51%
2015	24.1	24.6	0.5	1.97%
2016	24.1	24.6	0.5	1.98%
2017	22.7	23.1	0.4	1.96%
2018	17.2	17.5	0.4	2.11%
2019	10.6	10.6	0.0	0.00%
2020	10.0	10.0	0.0	0.00%
Total 2014-2038	294.1	296.2	2.1	0.73%

Continuing to run K1 and K2 increases revenue requirements by approximately $455,000 more on a net present value basis over the 25-year planning period than deactivating them. The difference in costs seen past 2019 is due to the difference in the revenue requirement stream for spending the capital to deactivate K1 and K2.

Table L170 Revenue Requirements Reference Case VS. Case 1

Analysis Period	Reference Case Revenue Requirement ($ '000)	Case 1 Revenue Requirement ($ '000)	Revenue Requirement Difference ($ '000)	Percent
2014	$283,171	$283,426	$256	0.09%
2015	$283,470	$283,571	$101	0.04%
2016	$288,534	$288,634	$101	0.03%
2017	$296,960	$297,121	$161	0.05%
2018	$320,252	$320,534	$282	0.09%
2019	$344,809	$344,755	-$54	-0.02%
2020	$359,935	$359,883	-$52	-0.01%
NPV 2014-2038	$3,996,263	$3,996,718	$455	0.01%

Continuing to run K1 and K2 results in a slightly higher heat rate in the period that it is deactivated in the Reference Case.

Table L171 MECO Overall Heat Rate Reference Case VS. Case 1

Analysis Period	Reference Case Heat Rate (Btu/kWh)	Case 1 Heat Rate (Btu/kWh)	Heat Rate Difference (Btu/kWh)	Percent
2014	10,002	10,069	67	0.67%
2015	10,002	10,047	44	0.44%
2016	10,027	10,074	47	0.47%
2017	10,028	10,079	51	0.51%
2018	9,949	10,014	65	0.66%
2019	9,254	9,254	0	0.00%
2020	9,257	9,257	0	0.00%

5. Reference Case vs. Case 2

Case 2 shows the potential reduction in curtailment that a 10 MW/15 MWh BESS (see Exhibit F for a more complete description) could have when used to provide regulating reserve. Prior to the retirement of KPP in 2019 (as well as for the entire duration of the simulation 2014-2038), there is a negligible effect on curtailment (less than 1 GWh). The BESS would be operational from the fourth quarter of 2017.

Several measures that address the need for regulating reserve are already included in the Reference Case. These measures include: implementation of the BESS at KWP II; allowing K3, K4, M15 and M18 to contribute to regulating reserve; and adoption of the HSIS reserve requirement. In Case 2, the application of the 10 MW/15 MWh BESS for regulating reserve was found to be ineffective in reducing curtailment because it is installed after the implementation of the measures included in the Reference Case. The BESS provides a small benefit in 2017 and 2018 before the first 17 MW internal combustion engines ("ICE") is installed in May 2018.

Table L172 Curtailment Reference Case VS. Case 2

Analysis Period	Reference Case Curtailment (GWH)	Case 2 Curtailment (GWH)	Curtailment Difference (GWH)	Curtailment Difference Percent
2014	25.7	25.7	0.0	0.00%
2015	24.1	24.1	0.0	0.00%
2016	24.1	24.1	0.0	0.00%
2017	22.7	22.3	-0.4	-1.78%
2018	17.2	16.8	-0.3	-1.95%
2019	10.6	10.6	0.0	0.00%
2020	10.0	10.0	0.0	0.00%
Total 2014-2038	294.1	293.3	-0.7	-0.25%

Installing a BESS for regulating reserve increases revenue requirements by approximately $38 million on a net present value basis over the 25-year planning period. The capital costs of the battery far outweigh the savings in fuel revenue requirements.

Table L173 Revenue Requirements Reference Case VS. Case 2

	Reference Case	Case 2	Revenue Requirement Difference	
	Revenue Requirement	Revenue Requirement		
Analysis Period	($ '000)	($ '000)	($ '000)	Percent
2014	$283,171	$283,171	$0	0.00%
2015	$283,470	$283,470	$0	0.00%
2016	$288,534	$288,534	$0	0.00%
2017	$296,960	$301,839	$4,879	1.64%
2018	$320,252	$326,637	$6,385	1.99%
2019	$344,809	$351,270	$6,460	1.87%
2020	$359,935	$366,090	$6,155	1.71%
NPV 2014-2038	$3,996,263	$4,034,225	$37,962	0.95%

With the addition of the BESS, the KPP units operate at slightly higher levels due to less need for regulating reserve. This decreases the heat rate at KPP, but increases the percentage of generation from KPP to the overall Maui Electric generation, slightly increasing the overall heat rate.

Table L174 MECO Overall Heat Rate Reference Case VS. Case 2

	Reference Case	Case 2	Heat Rate Difference	
	Heat Rate	Heat Rate		
Analysis Period	(Btu/kWh)	(Btu/kWh)	(Btu/kWh)	Percent
2014	10,002	10,002	0	0.00%
2015	10,002	10,002	0	0.00%
2016	10,027	10,027	0	0.00%
2017	10,028	10,030	2	0.02%
2018	9,949	9,952	3	0.03%
2019	9,254	9,254	0	0.00%
2020	9,257	9,257	0	0.00%

6. Reference Case vs. Case 3

D&O 31288 requires this plan to address the "utilization of demand response programs and energy storage technologies to reduce the need for on-line fossil generation to provide operating reserves and other ancillary services" (at 136). The Reference Case can be compared to Case 3 to determine the impact demand response ("DR") (see Exhibit H) would have on the timing of the need for additional generation, the need for ancillary services (i.e., regulating reserve) as well as on curtailment.[2] From a firm capacity perspective, implementing the DR programs described in Exhibit H will allow Maui Electric to avoid installing a 17 MW ICE in

[2] Case 7 models the impact of a 20 MW/160 MWh BESS. Case 8 models the impact of DR programs and a 20 MW/160 MWh BESS.

2018.[3] This, however, does not reduce curtailment significantly because the new ICE units are run only as needed and their quick starting ability partially reduces the regulating reserve requirement that the Maui Electric units carry. In addition, in the Reference Case, the baseload units that are operating already provide a sufficient amount of upward regulating reserve. No cycling units need to operate to provide upward regulating reserve. Therefore, the DR programs do not enable costs to be reduced by turning off cycling units since those units are already off. Furthermore, because curtailment tends to occur over many hours over the course of a day, the DR programs, as modeled, simply reduce curtailment in some hours and increase curtailment in other hours. The model is not able to determine when to dispatch the DR resources for optimal curtailment reduction since they are modeled as scheduled programs. In actual practice, it may be possible to dispatch the DR programs such that load on the system is reduced when curtailment is not expected and add load to the system when curtailment is expected. This will require that forecasting of as-available generation be refined. Over the years of the entire simulation (2014 – 2038), there is a 9.7 GWh reduction in curtailment from the load management programs. Prior to the retirement of KPP in 2019, there is a 1.4 GWh reduction in curtailment, which equates to a 1.2% curtailment reduction.

Table L175 Curtailment Reference Case VS. Case 3

	Reference Case	Case 3	Curtailment Difference	
Analysis Period	Curtailment (GWH)	Curtailment (GWH)	(GWH)	Percent
2014	25.7	25.6	-0.2	-0.64%
2015	24.1	23.6	-0.5	-1.99%
2016	24.1	23.8	-0.3	-1.31%
2017	22.7	22.3	-0.3	-1.43%
2018	17.2	17.1	-0.1	-0.34%
2019	10.6	10.5	-0.2	-1.64%
2020	10.0	9.9	-0.1	-0.78%
Total 2014-2038	294.1	284.4	-9.7	-3.28%

Implementing load management, as configured in the model run, could reduce the amount of capital spent on new generating units, but the programs also have an associated cost, which did exceed the amount saved. Load management would increase revenue requirements by approximately $23 million on a net present value basis over the 25-year planning period.

[3] See the table in the "Demand Response Budget and Timeline" section of Exhibit H. After 2018, the model run assumes the program costs and impacts will level off.

Table L176 Revenue Requirements Reference Case VS. Case 3

	Reference Case	Case 3	Revenue Requirement Difference	
	Revenue Requirement	Revenue Requirement		
Analysis Period	($ '000)	($ '000)	($ '000)	Percent
2014	$283,171	$286,360	$3,190	1.13%
2015	$283,470	$287,211	$3,740	1.32%
2016	$288,534	$293,108	$4,574	1.59%
2017	$296,960	$302,711	$5,751	1.94%
2018	$320,252	$318,901	-$1,350	-0.42%
2019	$344,809	$341,781	-$3,028	-0.88%
2020	$359,935	$356,846	-$3,089	-0.86%
NPV 2014-2038	$3,996,263	$4,019,369	$23,106	0.58%

Use of the load management programs could result in a slight reduction in the Maui Electric overall heat rate.

Table L177 MECO Overall Heat Rate Reference Case VS. Case 3

	Reference Case	Case 3	Heat Rate Difference	
	Heat Rate	Heat Rate		
Analysis Period	(Btu/kWh)	(Btu/kWh)	(Btu/kWh)	Percent
2014	10,002	10,002	0	0.00%
2015	10,002	10,001	-1	-0.01%
2016	10,027	10,018	-9	-0.09%
2017	10,028	10,021	-7	-0.07%
2018	9,949	9,946	-3	-0.03%
2019	9,254	9,250	-3	-0.04%
2020	9,257	9,252	-5	-0.05%

7. Reference Case vs. Case 4

Comparing the Reference Case against Case 4 shows the estimated curtailment reduction from cycling the K4 unit at KPP. This action will only have an effect prior to the planned retirement of KPP in 2019. There is a 13 GWh reduction in curtailment prior to 2019 by cycling K4, which is an 11.4% reduction in curtailment over the Reference Case.

Table L178 Curtailment Reference Case VS. Case 4

Analysis Period	Reference Case Curtailment (GWH)	Case 4 Curtailment (GWH)	Curtailment Difference (GWH)	Percent
2014	25.7	23.2	-2.5	-9.83%
2015	24.1	20.6	-3.5	-14.39%
2016	24.1	22.3	-1.8	-7.53%
2017	22.7	19.9	-2.8	-12.35%
2018	17.2	14.8	-2.4	-13.80%
2019	10.6	10.6	0.0	-0.34%
2020	10.0	10.0	0.0	0.00%
Total 2014-2038	294.1	281.0	-13.0	-4.43%

K4 is not designed for daily cycling operation and, as such, will incur extra costs due to the effects of cycling. These costs were developed by Intertek APTECH[4] and are added to the total cost of the case. Cycling K4 increases revenue requirements by approximately $27 million more than the Reference Case on a net present value basis over the 25-year planning period.

Table L179 Revenue Requirements Reference Case VS. Case 4

Analysis Period	Reference Case Revenue Requirement ($ '000)	Case 4 Revenue Requirement ($ '000)	Revenue Requirement Difference ($ '000)	Percent
2014	$283,171	$288,018	$4,847	1.71%
2015	$283,470	$290,659	$7,189	2.54%
2016	$288,534	$296,030	$7,497	2.60%
2017	$296,960	$304,317	$7,357	2.48%
2018	$320,252	$327,685	$7,434	2.32%
2019	$344,809	$344,809	$0	0.00%
2020	$359,935	$359,919	-$16	0.00%
NPV 2014-2038	$3,996,263	$4,023,160	$26,896	0.67%

It is anticipated that cycling K4 would reduce the Maui Electric overall heat rate.

[4] Intertek APTECH is a U.S.-based engineering consulting company specializing in the life management of infrastructure, facilities and equipment.

Table L180 MECO Overall Heat Rate Reference Case VS. Case 4

Analysis Period	Reference Case Heat Rate (Btu/kWh)	Case 4 Heat Rate (Btu/kWh)	Heat Rate Difference (Btu/kWh)	Heat Rate Difference Percent
2014	10,002	9,971	-32	-0.32%
2015	10,002	9,959	-43	-0.43%
2016	10,027	9,982	-45	-0.45%
2017	10,028	9,986	-42	-0.42%
2018	9,949	9,896	-53	-0.53%
2019	9,254	9,253	-1	-0.01%
2020	9,257	9,255	-2	-0.03%

8. Reference Case vs. Case 5

Case 5 is the addition of 5 MW biofueled ICEs in 2018 (1 engine), 2019 (7 engines), 2026 (1 engine), 2029 (1 engine), and 2035 (1 engine) to replace generation that will be lost with the retirement of KPP and to serve an anticipated increase in peak demand. The Reference Case includes one 17 MW biofueled ICE in 2018, two in 2019, and one in 2036 to replace generation that will be lost with the retirement of KPP and to serve an anticipated increase in peak demand. Case 5 provides an indication of the effect the generation additions will have on curtailment. Case 5 slightly increases curtailment over the Reference Case by 1.4 GWh, or 0.5% over the years 2014-2038 and has a negligible effect on curtailment prior to 2019.

Table L181 Curtailment Reference Case VS. Case 5

Analysis Period	Reference Case Curtailment (GWH)	Case 5 Curtailment (GWH)	Curtailment Difference (GWH)	Curtailment Difference Percent
2014	25.7	25.7	0.0	0.00%
2015	24.1	24.1	0.0	0.00%
2016	24.1	24.1	0.0	0.00%
2017	22.7	22.7	0.0	0.00%
2018	17.2	17.3	0.1	0.81%
2019	10.6	10.7	0.1	0.54%
2020	10.0	10.0	0.1	0.86%
Total 2014-2038	294.1	295.4	1.4	0.47%

The revenue requirements of Case 5 are greater than in the Reference Case by approximately $67.8 million on a net present value basis over the 25-year planning period. The 5 MW size requires more units than the 17 MW units in the Reference Case, which also leads to higher total O&M costs.

Table L182 Revenue Requirements Reference Case VS. Case 5

Analysis Period	Reference Case Revenue Requirement ($ '000)	Case 5 Revenue Requirement ($ '000)	Revenue Requirement Difference ($ '000)	Percent
2014	$283,171	$283,171	$0	0.00%
2015	$283,470	$283,470	$0	0.00%
2016	$288,534	$288,534	$0	0.00%
2017	$296,960	$296,960	$0	0.00%
2018	$320,252	$315,888	-$4,363	-1.36%
2019	$344,809	$349,504	$4,695	1.36%
2020	$359,935	$366,959	$7,024	1.95%
NPV 2014-2038	$3,996,263	$4,064,075	$67,811	1.70%

Case 5 results in a slightly higher Maui Electric overall heat rate.

Table L183 MECO Overall Heat Rate Reference Case VS. Case 5

Analysis Period	Reference Case Heat Rate (Btu/kWh)	Case 5 Heat Rate (Btu/kWh)	Heat Rate Difference (Btu/kWh)	Percent
2014	10,002	10,002	0	0.00%
2015	10,002	10,002	0	0.00%
2016	10,027	10,027	0	0.00%
2017	10,028	10,028	0	0.00%
2018	9,949	9,964	16	0.16%
2019	9,254	9,260	6	0.07%
2020	9,257	9,262	5	0.05%

9. Reference Case vs. Case 7

Case 7[5] includes a 20 MW/160 MWh BESS in lieu of the Kanaha-Waiinu transmission line in 2019 and the removal of the addition of one 17 MW ICE in 2019 and in 2036. (The Reference Case includes a standard transmission line between Waiinu and Kanaha substations.) These actions have no effect until 2019. From 2019 – 2038, Case 7 increases curtailment by 89.4 GWh over the Reference Case due to daily discharging of the battery for voltage support during the day, coincident with PV generation. The BESS is also charged daily during the off-peak hours, which reduces curtailment in those periods. However, the additional load on the system and subsequent additional wind energy acceptance is not enough to overcome the additional wind curtailment in the day time hours, when the BESS is discharging.

[5] As stated in Exhibit C, there is no Case 6.

Table L187 Curtailment Reference Case VS. Case 7

Analysis Period	Reference Case Curtailment (GWH)	Case 7 Curtailment (GWH)	Curtailment Difference (GWH)	Curtailment Difference Percent
2014	25.7	25.7	0.0	0.00%
2015	24.1	24.1	0.0	0.00%
2016	24.1	24.1	0.0	0.00%
2017	22.7	22.7	0.0	0.00%
2018	17.2	17.2	0.0	0.00%
2019	10.6	16.3	5.7	53.25%
2020	10.0	15.5	5.5	55.47%
Total 2014-2038	294.1	383.5	89.4	30.41%

The 20 MW/160MWh BESS replaces two 17 MW ICE units from the Reference Case, but increases the revenue requirements by approximately $250 million on a net present value basis over the 25-year planning period, compared to the Reference Case.

Table L188 Revenue Requirements Reference Case VS. Case 7

Analysis Period	Reference Case Revenue Requirement ($ '000)	Case 7 Revenue Requirement ($ '000)	Revenue Requirement Difference ($ '000)	Revenue Requirement Difference Percent
2014	$283,171	$283,171	$0	0.00%
2015	$283,470	$283,470	$0	0.00%
2016	$288,534	$288,534	$0	0.00%
2017	$296,960	$297,270	$310	0.10%
2018	$320,252	$316,488	-$3,763	-1.18%
2019	$344,809	$381,990	$37,181	10.78%
2020	$359,935	$412,828	$52,893	14.70%
NPV 2014-2038	$3,996,263	$4,245,876	$249,613	6.25%

The BESS reduces the Maui Electric overall heat rate.

Table L189 MECO Overall Heat Rate Reference Case VS. Case 7

Analysis Period	Reference Case Heat Rate (Btu/kWh)	Case 7 Heat Rate (Btu/kWh)	Heat Rate Difference (Btu/kWh)	Heat Rate Difference Percent
2014	10,002	10,002	0	0.00%
2015	10,002	10,002	0	0.00%
2016	10,027	10,027	0	0.00%
2017	10,028	10,028	0	0.00%
2018	9,949	9,949	0	0.00%
2019	9,254	9,208	-46	-0.50%
2020	9,257	9,209	-48	-0.52%

10. Reference Case vs. Case 8

In Case 8, a 17 MW ICE is added in 2019 and 2028 along with a 20 MW/160 MWh BESS in lieu of the Kanaha-Waiinu transmission line in 2019. In Case 8, DR decreases curtailment between 2014-2018 by 1.4 GWh (1.2%), but the combination of BESS and DR increase curtailment by 102 GWh over the years 2014-2038.

Table L190 Curtailment Reference Case VS. Case 8

Analysis Period	Reference Case Curtailment (GWH)	Case 8 Curtailment (GWH)	Curtailment Difference (GWH)	Curtailment Difference Percent
2014	25.7	25.6	-0.2	-0.64%
2015	24.1	23.6	-0.5	-1.99%
2016	24.1	23.8	-0.3	-1.31%
2017	22.7	22.3	-0.3	-1.43%
2018	17.2	17.1	-0.1	-0.34%
2019	10.6	18.5	7.9	73.85%
2020	10.0	16.7	6.7	67.41%
Total 2014-2038	294.1	396.5	102.5	34.85%

Case 8 increases revenue requirements by approximately $279 million on a net present value basis over the 25-year planning period.

Table L191 Revenue Requirements Reference Case VS. Case 8

Analysis Period	Reference Case Revenue Requirement ($ '000)	Case 8 Revenue Requirement ($ '000)	Revenue Requirement Difference ($ '000)	Revenue Requirement Difference Percent
2014	$283,171	$286,360	$3,190	1.13%
2015	$283,470	$287,211	$3,740	1.32%
2016	$288,534	$293,108	$4,574	1.59%
2017	$296,960	$303,021	$6,061	2.04%
2018	$320,252	$315,138	-$5,113	-1.60%
2019	$344,809	$379,776	$34,967	10.14%
2020	$359,935	$410,545	$50,611	14.06%
NPV 2014-2038	$3,996,263	$4,274,802	$278,539	6.97%

Case 8 has the potential to slightly reduce the Maui Electric overall heat rate.

Table L192 MECO Overall Heat Rate Reference Case VS. Case 8

Analysis Period	Reference Case Heat Rate (Btu/kWh)	Case 8 Heat Rate (Btu/kWh)	Heat Rate Difference (Btu/kWh)	Percent
2014	10,002	10,002	0	0.00%
2015	10,002	10,001	-1	-0.01%
2016	10,027	10,018	-9	-0.09%
2017	10,028	10,021	-7	-0.07%
2018	9,949	9,946	-3	-0.03%
2019	9,254	9,237	-17	-0.18%
2020	9,257	9,227	-31	-0.33%

11. Reference Case vs. Case 9

In Case 9, improvements are made to enable M14 or M16, and M15 to operate in single-train combined cycle ("STCC1") mode. Currently, M14, M15, and M16 operate in dual-train combined cycle ("DTCC1") as a baseloaded unit. The improvements result in a curtailment reduction of 37.6 GWh from 2014-2018 (33%) and 97.4 GWh (33.1%) from 2014-2038.

Table L193 Curtailment Reference Case VS. Case 9

Analysis Period	Reference Case Curtailment (GWH)	Case 9 Curtailment (GWH)	Curtailment Difference (GWH)	Percent
2014	25.7	25.7	0.0	0.00%
2015	24.1	24.1	0.0	0.00%
2016	24.1	10.6	-13.6	-56.24%
2017	22.7	10.0	-12.7	-56.07%
2018	17.2	5.9	-11.3	-65.81%
2019	10.6	7.0	-3.7	-34.50%
2020	10.0	6.1	-3.9	-38.87%
Total 2014-2038	294.1	196.6	-97.4	-33.14%

The increase in revenue requirements associated with enabling STCC1 to be baseloaded is about $12.7 million over the years 2014-2038.

Table L194 Revenue Requirements Reference Case VS. Case 9

Analysis Period	Reference Case Revenue Requirement ($ '000)	Case 9 Revenue Requirement ($ '000)	Revenue Requirement Difference ($ '000)	Revenue Requirement Difference Percent
2014	$283,171	$283,171	$0	0.00%
2015	$283,470	$283,470	$0	0.00%
2016	$288,534	$289,707	$1,173	0.41%
2017	$296,960	$298,505	$1,545	0.52%
2018	$320,252	$322,095	$1,843	0.58%
2019	$344,809	$346,525	$1,716	0.50%
2020	$359,935	$361,470	$1,535	0.43%
NPV 2014-2038	$3,996,263	$4,008,982	$12,718	0.32%

Case 9 results in a higher overall heat rate due to the lower efficiency of STCC1 operation of M14, M15, and M16.

Table L195 MECO Overall Heat Rate Reference Case VS. Case 9

Analysis Period	Reference Case Heat Rate (Btu/kWh)	Case 9 Heat Rate (Btu/kWh)	Heat Rate Difference (Btu/kWh)	Heat Rate Difference Percent
2014	10,002	10,002	0	0.00%
2015	10,002	10,002	0	0.00%
2016	10,027	10,093	65	0.65%
2017	10,028	10,099	71	0.70%
2018	9,949	10,009	60	0.60%
2019	9,254	9,273	19	0.20%
2020	9,257	9,276	19	0.20%

12. Reference Case vs. Case 10

In Case 10, the baseloaded units are changed from DTCC1, Maalaea units M17 and M18 in single-train combined cycle (“STCC2”), K3 and K4 (in the Reference Case) to M17 and M19 (in simple cycle), K3 and K4. Case 10 lowers curtailment by 34.3 GWh (30.1%) in 2014-2018 and 116.1 GWh (39.5%) from 2014-2038.

Table L196 Curtailment Reference Case VS. Case 10

Analysis Period	Reference Case Curtailment (GWH)	Case 10 Curtailment (GWH)	Curtailment Difference (GWH)	Percent
2014	25.7	16.9	-8.9	-34.50%
2015	24.1	17.8	-6.3	-26.33%
2016	24.1	16.5	-7.6	-31.52%
2017	22.7	16.9	-5.7	-25.26%
2018	17.2	11.4	-5.7	-33.37%
2019	10.6	6.8	-3.8	-35.81%
2020	10.0	5.5	-4.5	-45.30%
Total 2014-2038	294.1	178.0	-116.1	-39.48%

Operating M17 and M19 in simple cycle mode as baseloaded units increases revenue requirements over the Reference Case by approximately $216 million. The increase in revenue requirements is due primarily to operating these units in simple cycle mode, which is very fuel inefficient.

Table L197 Revenue Requirements Reference Case VS. Case 10

Analysis Period	Reference Case Revenue Requirement ($ '000)	Case 10 Revenue Requirement ($ '000)	Revenue Requirement Difference ($ '000)	Percent
2014	$283,171	$297,410	$14,240	5.03%
2015	$283,470	$293,180	$9,710	3.43%
2016	$288,534	$298,365	$9,832	3.41%
2017	$296,960	$309,456	$12,497	4.21%
2018	$320,252	$339,456	$19,204	6.00%
2019	$344,809	$361,407	$16,598	4.81%
2020	$359,935	$383,131	$23,196	6.44%
NPV 2014-2038	$3,996,263	$4,212,747	$216,483	5.42%

In simple cycle mode, M17 and M19 have much higher overall heat rates and will consume more fuel than the Reference Case. The overall Maui Electric heat rate dramatically increases.

Table L198 MECO Overall Heat Rate Reference Case VS. Case 10

Analysis Period	Reference Case Heat Rate (Btu/kWh)	Case 10 Heat Rate (Btu/kWh)	Heat Rate Difference (Btu/kWh)	Percent
2014	10,002	10,947	944	9.44%
2015	10,002	10,636	633	6.33%
2016	10,027	10,586	559	5.57%
2017	10,028	10,695	667	6.65%
2018	9,949	10,880	931	9.36%
2019	9,254	9,863	609	6.58%
2020	9,257	10,104	846	9.14%

13. Reference Case vs. Case 11

In Case 11, improvements are made to DTCC1 that enable operation at lower minimum outputs. Additional improvements to DTCC1 also enable STCC1 to be baseloaded, with M16 cycling on and off. These two actions resulted in a 56.4 GWh (49.5%) reduction in curtailment between 2016 and 2018 and a 217.9 GWh (74.1%) reduction between 2014 and 2038.

Table L199 Curtailment Reference Case VS. Case 11

Analysis Period	Reference Case Curtailment (GWH)	Case 11 Curtailment (GWH)	Curtailment Difference (GWH)	Curtailment Difference Percent
2014	25.7	25.7	0.0	0.00%
2015	24.1	24.1	0.0	0.00%
2016	24.1	3.4	-20.7	-86.02%
2017	22.7	2.7	-20.0	-88.10%
2018	17.2	1.5	-15.6	-91.16%
2019	10.6	1.0	-9.7	-90.72%
2020	10.0	0.8	-9.2	-91.93%
Total 2014-2038	294.1	76.1	-217.9	-74.12%

The increase in revenue requirements associated with the above measures is approximately $5.1million over the analysis period. The operation of STCC1 incurs cycling costs[6] that are not incurred in the current operations of baseloading DTCC1. The cycling costs combined with the capital cost to upgrade the units to be baseloaded in single-train combined cycle operation are greater than the fuel savings from running at lower minimum outputs.

Table L200 Revenue Requirements Reference Case VS. Case 11

Analysis Period	Reference Case Revenue Requirement ($ '000)	Case 11 Revenue Requirement ($ '000)	Revenue Requirement Difference ($ '000)	Revenue Requirement Difference Percent
2014	$283,171	$283,171	$0	0.00%
2015	$283,470	$283,470	$0	0.00%
2016	$288,534	$288,727	$193	0.07%
2017	$296,960	$297,470	$510	0.17%
2018	$320,252	$321,377	$1,125	0.35%
2019	$344,809	$345,802	$993	0.29%
2020	$359,935	$360,763	$828	0.23%
NPV 2014-2038	$3,996,263	$4,001,348	$5,084	0.13%

Case 11 increases the overall Maui Electric heat rate with the higher heat rates at lower minimum loads and single-train operation of M14, M15, and M16.

[6] Cycling costs are explained in Section F.4.j. in Exhibit C.

Table L201 MECO Overall Heat Rate Reference Case VS. Case 11

Analysis Period	Reference Case Heat Rate (Btu/kWh)	Case 11 Heat Rate (Btu/kWh)	Heat Rate Difference (Btu/kWh)	Heat Rate Difference Percent
2014	10,002	10,002	0	0.00%
2015	10,002	10,002	0	0.00%
2016	10,027	10,097	70	0.70%
2017	10,028	10,102	74	0.74%
2018	9,949	9,998	49	0.49%
2019	9,254	9,271	17	0.18%
2020	9,257	9,269	12	0.13%

14. Reference Case vs. Case 12

In Case 12, STCC2 is removed from baseloaded operation designation and operated at lower minimum outputs. Overall, this reduces curtailment by 89.1 GWh (78.3%) during the years 2014-2018 and 257.7 GWh (87.7%) from 2014-2038. This case, and the associated measures taken, results in the largest reduction in curtailment during 2014-2038 of any case analyzed.

Table L202 Curtailment Reference Case VS. Case 12

Analysis Period	Reference Case Curtailment (GWH)	Case 12 Curtailment (GWH)	Curtailment Difference (GWH)	Curtailment Difference Percent
2014	25.7	9.7	-16.0	-62.26%
2015	24.1	10.0	-14.1	-58.58%
2016	24.1	2.4	-21.7	-90.02%
2017	22.7	1.8	-20.9	-92.19%
2018	17.2	0.8	-16.3	-95.24%
2019	10.6	0.5	-10.1	-95.04%
2020	10.0	0.5	-9.5	-95.19%
Total 2014-2038	294.1	36.3	-257.7	-87.65%

The estimated revenue requirement savings associated with Case 12 is approximately $3.4 million.

Table L203 Revenue Requirements Reference Case VS. Case 12

Analysis Period	Reference Case Revenue Requirement ($ '000)	Case 12 Revenue Requirement ($ '000)	Revenue Requirement Difference ($ '000)	Revenue Requirement Difference Percent
2014	$283,171	$282,109	-$1,061	-0.37%
2015	$283,470	$282,504	-$966	-0.34%
2016	$288,534	$288,325	-$209	-0.07%
2017	$296,960	$296,900	-$60	-0.02%
2018	$320,252	$321,103	$851	0.27%
2019	$344,809	$344,767	-$42	-0.01%
2020	$359,935	$359,886	-$49	-0.01%
NPV 2014-2038	$3,996,263	$3,992,824	-$3,440	-0.09%

The overall Maui Electric heat rate decreases slightly in 2014 and 2015 when operating only DTCC1 and K3 andK4 as baseloaded units. Starting in 2016, following the completion of the upgrades to units M14 and M16, they are able to operate at lower minimum loads and the overall Maui Electric heat rate increases.

Table L204 MECO Overall Heat Rate Reference Case VS. Case 12

Analysis Period	Reference Case Heat Rate (Btu/kWh)	Case 12 Heat Rate (Btu/kWh)	Heat Rate Difference (Btu/kWh)	Heat Rate Difference Percent
2014	10,002	9,959	-44	-0.44%
2015	10,002	9,963	-39	-0.39%
2016	10,027	10,077	49	0.49%
2017	10,028	10,074	46	0.46%
2018	9,949	9,982	33	0.33%
2019	9,254	9,265	11	0.12%
2020	9,257	9,263	6	0.06%

15. Reference Case vs. Case 13

In Case 13, improvements are made to DTCC1 to operate at lower minimum outputs. The overall reduction in curtailment is 49.8 GWh (43.9%) in 2014-2018 and 200.1 GWh from 2014 -2038 (68.1%).

Table L205 Curtailment Reference Case VS. Case 13

Analysis Period	Reference Case Curtailment (GWH)	Case 13 Curtailment (GWH)	Curtailment Difference (GWH)	Percent
2014	25.7	25.7	0.0	0.00%
2015	24.1	24.1	0.0	0.00%
2016	24.1	5.9	-18.2	-75.57%
2017	22.7	5.0	-17.6	-77.84%
2018	17.2	3.1	-14.0	-81.76%
2019	10.6	1.8	-8.9	-83.50%
2020	10.0	1.6	-8.4	-84.40%
Total 2014-2038	294.1	93.9	-200.1	-68.05%

The lower minimum outputs on DTCC1 result in an estimated revenue requirement savings of approximately $5.6 million. This is a greater savings than Case 12 because cycling costs are not incurred from having M17 or M19 operating in single-train combined cycle with M18 as a baseloaded unit.

Table L206 Revenue Requirements Reference Case VS. Case 13

Analysis Period	Reference Case Revenue Requirement ($ '000)	Case 13 Revenue Requirement ($ '000)	Revenue Requirement Difference ($ '000)	Percent
2014	$283,171	$283,171	$0	0.00%
2015	$283,470	$283,470	$0	0.00%
2016	$288,534	$287,475	-$1,058	-0.37%
2017	$296,960	$296,006	-$954	-0.32%
2018	$320,252	$319,541	-$711	-0.22%
2019	$344,809	$344,517	-$292	-0.08%
2020	$359,935	$359,637	-$298	-0.08%
NPV 2014-2038	$3,996,263	$3,990,575	-$5,688	-0.14%

The lower minimum loads of DTCC1 increases the overall Maui Electric heat rate.

Table L207 MECO Overall Heat Rate Reference Case VS. Case 13

Analysis Period	Reference Case Heat Rate (Btu/kWh)	Case 13 Heat Rate (Btu/kWh)	Heat Rate Difference (Btu/kWh)	Percent
2014	10,002	10,002	0	0.00%
2015	10,002	10,002	0	0.00%
2016	10,027	10,106	78	0.78%
2017	10,028	10,104	76	0.76%
2018	9,949	10,002	53	0.53%
2019	9,254	9,272	18	0.20%
2020	9,257	9,273	15	0.17%

By comparing Case 13 to Case 12, the reduction in curtailment from removing STCC2 from the baseloaded unit status can be determined (since it is the only difference between Case 12 and Case 13.) Removing baseload status of STCC2 has a curtailment reduction of 39.2 GWh (61.3%) from 2014-2018 and 57.6 GWh (61.4%) from 2014-2038.

16. Reference Case vs. Case 14

Case 14 evaluates the possibility of DTCC1 and DTCC2 converting to liquid natural gas ("LNG"). This is primarily to evaluate the economics of switching to a potentially lower cost fuel. The fuel switch does not impact curtailment, as can be seen from the table below.

Table L208 Curtailment Reference Case VS. Case 14

Analysis Period	Reference Case Curtailment (GWH)	Case 14 Curtailment (GWH)	Curtailment Difference (GWH)	Curtailment Difference Percent
2014	25.7	25.7	0.0	0.00%
2015	24.1	24.1	0.0	0.00%
2016	24.1	24.1	0.0	0.00%
2017	22.7	22.7	0.0	0.00%
2018	17.2	17.2	0.0	0.00%
2019	10.6	10.6	0.0	0.00%
2020	10.0	10.0	0.0	0.00%
Total 2014-2038	294.1	294.1	0.0	0.00%

Converting the combustion turbines M14, M16, M17, and M19 to LNG in 2021 could reduce revenue requirements by approximately $199 million on a net present value basis over the 25-year planning period.

Table L209 Revenue Requirements Reference Case VS. Case 14

Analysis Period	Reference Case Revenue Requirement ($ '000)	Case 14 Revenue Requirement ($ '000)	Revenue Requirement Difference ($ '000)	Revenue Requirement Difference Percent
2014	$283,171	$283,171	$0	0.00%
2015	$283,470	$283,470	$0	0.00%
2016	$288,534	$288,534	$0	0.00%
2017	$296,960	$296,960	$0	0.00%
2018	$320,252	$320,252	$0	0.00%
2019	$344,809	$344,809	$0	0.00%
2020	$359,935	$359,935	$0	0.00%
NPV 2014-2038	$3,996,263	$3,797,061	-$199,202	-4.98%

Table L210 MECO Overall Heat Rate Reference Case VS. Case 14

	Reference Case	Case 14	Heat Rate Difference	
Analysis Period	Heat Rate (Btu/kWh)	Heat Rate (Btu/kWh)	(Btu/kWh)	Percent
2014	10,002	10,002	0	0.00%
2015	10,002	10,002	0	0.00%
2016	10,027	10,027	0	0.00%
2017	10,028	10,028	0	0.00%
2018	9,949	9,949	0	0.00%
2019	9,254	9,254	0	0.00%
2020	9,257	9,257	0	0.00%

17. Reference Case vs. Case 15

Case 15 evaluates the impact of a higher PV forecast. Exhibit C, Attachment C2 describes the difference between the forecasts. The higher PV forecast, as would be expected, increases curtailment by offsetting load that the curtailable facilities would have served. The increase in curtailment is equal to 11.8 GWh (10.4% increase) from 2014 to 2018 and 393.5 GWh from 2014 through 2038 (134% increase). The Company performed this case to test the sensitivity of variations in the PV forecast assumption. It is not a Maui Electric action item that the Company would consider for implementation in comparison with the other cases in this plan.

Table L211 Curtailment Reference Case VS. Case 15

	Reference Case	Case 15	Curtailment Difference	
Analysis Period	Curtailment (GWH)	Curtailment (GWH)	(GWH)	Percent
2014	25.7	25.8	0.0	0.05%
2015	24.1	24.1	0.0	0.12%
2016	24.1	24.1	0.0	0.04%
2017	22.7	26.2	3.5	15.45%
2018	17.2	25.4	8.3	48.28%
2019	10.6	19.7	9.1	85.46%
2020	10.0	22.9	13.0	130.30%
Total 2014-2038	294.1	687.5	393.5	133.81%

The higher amount of PV reduces the revenue requirements by approximately $135 million on a net present value basis over the 25-year planning period.[7] This is due to less units running, less fuel used, and less payments made to the curtailable facilities from purchasing less energy.

[7] The PV is assumed to be installed and paid for by individual customers. These customer costs are not included in utility revenue requirements.

Table L212 Revenue Requirements Reference Case VS. Case 15

Analysis Period	Reference Case Revenue Requirement ($ '000)	Case 15 Revenue Requirement ($ '000)	Revenue Requirement Difference ($ '000)	Revenue Requirement Difference Percent
2014	$283,171	$283,155	-$15	-0.01%
2015	$283,470	$283,449	-$21	-0.01%
2016	$288,534	$288,506	-$28	-0.01%
2017	$296,960	$294,946	-$2,014	-0.68%
2018	$320,252	$314,933	-$5,319	-1.66%
2019	$344,809	$335,824	-$8,986	-2.61%
2020	$359,935	$348,744	-$11,191	-3.11%
NPV 2014-2038	$3,996,263	$3,861,488	-$134,776	-3.37%

The higher PV penetration increases the Maui Electric overall heat rate.

Table L213 MECO Overall Heat Rate Reference Case VS. Case 15

Analysis Period	Reference Case Heat Rate (Btu/kWh)	Case 15 Heat Rate (Btu/kWh)	Heat Rate Difference (Btu/kWh)	Heat Rate Difference Percent
2014	10,002	10,002	0	0.00%
2015	10,002	10,003	0	0.00%
2016	10,027	10,028	0	0.00%
2017	10,028	10,044	16	0.16%
2018	9,949	10,000	51	0.52%
2019	9,254	9,312	58	0.63%
2020	9,257	9,326	69	0.74%

18. Reference Case vs. Case 16

Case 16 evaluates continuing to use the current regulating reserve requirement from the Maui Wind Integration Study ("WIS"), as opposed to the HSIS proposed reserve requirements contained within the Reference Case. As the table below shows, switching to the HSIS reserve requirement reduces curtailment by 12.3 GWh (9.7%) from 2014 to 2018 and by 27.6 GWh (8.4%) from 2014–2038. Subtracting 12.3 GWh from 13.7 GWh (the reduction from K1 and K2 deactivation and the adoption of the HSIS reserve requirement determined in the previous comparison) results in 1.4 GWh (1.2%) of curtailment reduction associated with the deactivation of K1 and K2.

Table L214 Curtailment Reference Case VS. Case 16

Analysis Period	Reference Case Curtailment (GWH)	Case 16 Curtailment (GWH)	Curtailment Difference (GWH)	Percent
2014	25.7	28.5	2.8	10.87%
2015	24.1	25.6	1.5	6.17%
2016	24.1	28.3	4.2	17.55%
2017	22.7	25.5	2.9	12.58%
2018	17.2	18.1	0.9	5.25%
2019	10.6	11.8	1.1	10.41%
2020	10.0	10.3	0.3	2.94%
Total 2014-2038	294.1	321.6	27.6	9.37%

Case 16 shows that using the WIS regulating reserve requirement would increase the revenue requirements over the Reference Case by approximately $3.8 million, due primarily to higher fuel revenue requirements that are partially offset by lower purchased energy revenue requirements.

Table L215 Revenue Requirements Reference Case VS. Case 16

Analysis Period	Reference Case Revenue Requirement ($ '000)	Case 16 Revenue Requirement ($ '000)	Revenue Requirement Difference ($ '000)	Percent
2014	$283,171	$283,209	$39	0.01%
2015	$283,470	$283,591	$121	0.04%
2016	$288,534	$288,783	$249	0.09%
2017	$296,960	$297,337	$378	0.13%
2018	$320,252	$321,002	$750	0.23%
2019	$344,809	$345,246	$437	0.13%
2020	$359,935	$360,160	$225	0.06%
NPV 2014-2038	$3,996,263	$4,000,037	$3,773	0.09%

Using the WIS regulating reserve would yield a higher overall Maui Electric heat rate.

Table L216 MECO Overall Heat Rate Reference Case VS. Case 16

Analysis Period	Reference Case Heat Rate (Btu/kWh)	Case 16 Heat Rate (Btu/kWh)	Heat Rate Difference (Btu/kWh)	Percent
2014	10,002	10,021	18	0.18%
2015	10,002	10,031	29	0.29%
2016	10,027	10,045	18	0.18%
2017	10,028	10,055	27	0.27%
2018	9,949	9,967	18	0.18%
2019	9,254	9,261	7	0.08%
2020	9,257	9,263	5	0.06%

Table L210 MECO Overall Heat Rate Reference Case VS. Case 16

	Reference Case	Case 16	Heat Rate Difference	
	Heat Rate	Heat Rate		
Analysis Period	(Btu/kWh)	(Btu/kWh)	(Btu/kWh)	Percent
2014	10,002	10,021	18	0.18%
2015	10,002	10,031	29	0.29%
2016	10,027	10,045	18	0.18%
2017	10,028	10,055	27	0.27%
2018	9,949	9,967	18	0.18%
2019	9,254	9,261	7	0.08%
2020	9,257	9,263	5	0.06%

19. Reference Case vs. Case 17

In Case 17, the STCC2 (M17 or M19 with M18) is removed from the baseloaded units, and M18 is not operated unless there is an anticipated capacity shortfall situation like maintenance of a large unit. This has the effect of reducing curtailment by 66.9 GWh (58.8%) from 2014 to 2018 and 194 GWh (66.0%) from 2014-2038.

Table L217 Curtailment Reference Case VS. Case 17

	Reference Case	Case 17	Curtailment Difference	
	Curtailment	Curtailment		
Analysis Period	(GWH)	(GWH)	(GWH)	Percent
2014	25.7	6.0	-19.7	-76.66%
2015	24.1	11.6	-12.5	-51.80%
2016	24.1	11.4	-12.7	-52.66%
2017	22.7	11.4	-11.3	-49.65%
2018	17.2	6.4	-10.7	-62.55%
2019	10.6	4.4	-6.2	-58.53%
2020	10.0	1.4	-8.5	-85.72%
Total 2014-2038	294.1	100.1	-194.0	-65.96%

The estimated revenue requirement increase associated with implementing the above changes is $105 million on a net present value bases over the 25-year planning period when compared to the Reference Case. Operating M17 and M19 in simple cycle mode uses more fuel and reactivating the steam turbine, M18, increases the cycling costs.

Table L218 Revenue Requirements Reference Case VS. Case 17

Analysis Period	Reference Case Revenue Requirement ($ '000)	Case 17 Revenue Requirement ($ '000)	Revenue Requirement Difference ($ '000)	Percent
2014	$283,171	$286,317	$3,146	1.11%
2015	$283,470	$285,545	$2,075	0.73%
2016	$288,534	$289,528	$994	0.34%
2017	$296,960	$298,924	$1,964	0.66%
2018	$320,252	$325,562	$5,310	1.66%
2019	$344,809	$354,780	$9,971	2.89%
2020	$359,935	$373,643	$13,709	3.81%
NPV 2014-2038	$3,996,263	$4,101,011	$104,747	2.62%

The simple cycle operation of the CTs results in a higher overall Maui Electric heat rate.

Table L219 MECO Overall Heat Rate Reference Case VS. Case 17

Analysis Period	Reference Case Heat Rate (Btu/kWh)	Case 17 Heat Rate (Btu/kWh)	Heat Rate Difference (Btu/kWh)	Percent
2014	10,002	10,501	499	4.99%
2015	10,002	10,322	320	3.20%
2016	10,027	10,283	255	2.55%
2017	10,028	10,332	304	3.04%
2018	9,949	10,420	471	4.73%
2019	9,254	9,569	315	3.41%
2020	9,257	9,689	432	4.66%

20. Reference Case vs. Case 18

Case 18 removes STCC2 from baseloaded operation. The difference between Case 17 and Case 18 is that in Case 17, M18 (steam turbine on DTCC2) is not operated in STCC or DTCC mode unless there is an anticipated capacity shortfall. In Case 18, M18 is allowed to operate in STCC or DTCC mode on a daily basis. In Case 18, cycling costs for M18 would be incurred while in Case 17, it would not be incurred since M18 would not be cycled on a daily basis. The curtailment reduction from making that change is equal to 63.8 GWh (56.1%) from 2014-2018 and 113.2 GWh (38.5%) from 2014-2038.

Table L220 Curtailment Reference Case VS. Case 18

Analysis Period	Reference Case Curtailment (GWH)	Case 18 Curtailment (GWH)	Curtailment Difference (GWH)	Curtailment Difference Percent
2014	25.7	9.7	-16.0	-62.26%
2015	24.1	10.0	-14.1	-58.58%
2016	24.1	12.0	-12.2	-50.42%
2017	22.7	11.3	-11.4	-50.08%
2018	17.2	7.0	-10.2	-59.30%
2019	10.6	7.4	-3.2	-30.50%
2020	10.0	6.6	-3.4	-33.71%
Total 2014-2038	294.1	180.9	-113.2	-38.49%

By removing the second single-train combined cycle from baseloaded operations a revenue requirements savings of approximately $4.9 million can be achieved from saving on fuel.

Table L221 Revenue Requirements Reference Case VS. Case 18

Analysis Period	Reference Case Revenue Requirement ($ '000)	Case 18 Revenue Requirement ($ '000)	Revenue Requirement Difference ($ '000)	Revenue Requirement Difference Percent
2014	$283,171	$282,120	-$1,050	-0.37%
2015	$283,470	$282,503	-$967	-0.34%
2016	$288,534	$287,754	-$780	-0.27%
2017	$296,960	$296,195	-$765	-0.26%
2018	$320,252	$319,701	-$550	-0.17%
2019	$344,809	$344,573	-$236	-0.07%
2020	$359,935	$359,708	-$227	-0.06%
NPV 2014-2038	$3,996,263	$3,991,366	-$4,898	-0.12%

Case 18 could reduce the Maui Electric overall heat rate.

Table L222 MECO Overall Heat Rate Reference Case VS. Case 18

Analysis Period	Reference Case Heat Rate (Btu/kWh)	Case 18 Heat Rate (Btu/kWh)	Heat Rate Difference (Btu/kWh)	Heat Rate Difference Percent
2014	10,002	9,957	-45	-0.45%
2015	10,002	9,962	-41	-0.41%
2016	10,027	9,995	-32	-0.32%
2017	10,028	9,994	-34	-0.34%
2018	9,949	9,907	-42	-0.42%
2019	9,254	9,243	-11	-0.12%
2020	9,257	9,247	-11	-0.12%

21. Reference Case vs. Case 19

Case 19 removes the steam turbine (M18) of the STCC2 from operation during 2014 and 2015 (using it only when needed for capacity). M17 and M19 are operated as peaking units to reduce the impact of lower heat rates when operating in simple cycle mode. Then starting 2016, upgrades are made to DTCC1 to decrease the minimum output ratings when running in dual-train combined cycle. Curtailment is reduced by 82 GWh from 2014 to 2018 and the overall curtailment reduction is 232.3 GWh over the 25-year planning period.

Table L223 Curtailment Reference Case VS. Case 19

	Reference Case	Case 19	Curtailment Difference	
Analysis Period	Curtailment (GWH)	Curtailment (GWH)	(GWH)	Percent
2014	25.7	6.0	-19.7	-76.54%
2015	24.1	11.6	-12.5	-51.82%
2016	24.1	5.9	-18.2	-75.57%
2017	22.7	5.0	-17.6	-77.84%
2018	17.2	3.1	-14.0	-81.76%
2019	10.6	1.8	-8.9	-83.50%
2020	10.0	1.6	-8.4	-84.40%
Total 2014-2038	294.1	61.8	-232.3	-79.00%

Case 19 saves on fuel and will reduce the revenue requirements by approximately $7.7 million on a net present value basis over the 25-year planning period.

Table L224 Revenue Requirements Reference Case VS. Case 19

	Reference Case	Case 19	Revenue Requirement Difference	
Analysis Period	Revenue Requirement ($ '000)	Revenue Requirement ($ '000)	($ '000)	Percent
2014	$283,171	$282,057	-$1,114	-0.39%
2015	$283,470	$282,276	-$1,194	-0.42%
2016	$288,534	$287,475	-$1,058	-0.37%
2017	$296,960	$296,003	-$957	-0.32%
2018	$320,252	$319,541	-$711	-0.22%
2019	$344,809	$344,517	-$292	-0.08%
2020	$359,935	$359,637	-$298	-0.08%
NPV 2014-2038	$3,996,263	$3,988,521	-$7,743	-0.19%

Case 19 increases the overall Maui Electric heat rate over the Reference Case in 2014 and 2015 when M17 and M19 are operated in simple cycle, but is not as high as in Case 17 or Case 10 because they are activated later in the commitment order.

Table L225 MECO Overall Heat Rate Reference Case VS. Case 19

Analysis Period	Reference Case Heat Rate (Btu/kWh)	Case 19 Heat Rate (Btu/kWh)	Heat Rate Difference (Btu/kWh)	Heat Rate Difference Percent
2014	10,002	10,246	243	2.43%
2015	10,002	10,132	130	1.30%
2016	10,027	10,106	78	0.78%
2017	10,028	10,104	76	0.76%
2018	9,949	10,002	53	0.53%
2019	9,254	9,272	18	0.20%
2020	9,257	9,273	15	0.17%

E. Fuel Efficiency

Many of the candidate actions to reduce curtailment will result in an increase in Maui Electric's heat rates by fuel type. Exhibit C, Attachment C3 provides more detailed discussion on the efficiency of generators at different output levels. For example, changing how one or both of the dual train combined cycle units operate will result in a substantial increase in Maui Electric's diesel heat rate.

Currently, DTCC1 operates as a must-run (i.e., baseloaded) unit with a minimum output rating of 34.98 MW-net. For DTCC2, one-half of the combined cycle operates as a must-run unit (i.e., only one of the combustion turbines plus the steam turbine operating at one-half load are baseloaded). This is called single train combined cycle ("STCC") operation. The minimum output rating of the STCC is 16.54 MW-net.

In Case 9, the operation of DTCC1 is changed from must-run to where only one-half of it is baseloaded such that it operates as an STCC. The other half will be allowed to cycle off as necessary to accept more as-available renewable generation. For the purposes of the modeling, it was assumed that the change would occur in 2016. As can be seen in Table L107, Maui Electric's diesel heat rate increases from 9,315 Btu/kWh-net in 2015 to 9,377 Btu/kWh-net in 2016. The increase in diesel heat rate is the result of the units using diesel fuel operating less efficiently as a whole because one-half of the very efficient DTCC1 operates less frequently. These heat rate results reflect the inputs of the model which have slightly higher minimums to carry the downward regulating reserve as specified in the MOMs.[8]

[8] MOMs down regulating reserve defined in Exhibit 1 – Power Purchase Agreement with Kaheawa Wind Power II LLC, pages 173 to 174 in Docket 2010-0279.

In Case 11, the change in operation of DTCC1 would be the same as in Case 9. In Case 11, however, the minimum output rating of DTCC1 when operating in STCC mode would be reduced from 15.72 MW-net to 9.5 MW-net. As shown in Table L117, Maui Electric's diesel heat rate increases from 9,315 Btu/kWh-net in 2015 to 9,374 Btu/kWh-net in 2016. The increase in diesel heat rate is the result of DTCC1 operating in STCC mode and at lower outputs where it runs less efficiently.

Similar results can be seen in Case 12 (see Table L122), Case 13 (see Table L127), and Case 18 (see Table L152) where the operation of DTCC1 and/or DTCC2 is changed compared to the Reference Case.

In Case 10, Case 17, and Case 19, the operation of DTCC2 is changed by not running the steam turbine, M18, of the combined cycle. This leaves M17 and M19 operating in simple cycle ("SC") mode. M18 is assumed to not run starting March of 2014. The difference in operation is seen by comparison to the Reference Case, starting in 2014. Changes in the heat rate vary depending on where in the commitment order of M17 and M19 are placed. In Case 10, M17 and M19 are baseloaded and Maui Electric's diesel heat rate increases from 9,325 Btu/kWh-net in 2014 (see Table L62) in the Reference Case to 10,265 Btu/kWh-net in Case 10 (See Table L112). In Case 17, M17 is committed as the first cycler and M19 is committed as the last cycler which increases the heat rate to 9,723 Btu/kWh-net in 2014 (See Table L147). In Case 19, M17 and M19 are committed as the last cycling units and the heat rate increases to 9,419 Btu/kWh-net in 2014 (see Table L157).

Maui Electric-Maui Division's Energy Cost Adjustment Clause (Revised Sheet 69B, effective June 1, 2012) provides conditions under which Maui Electric's target heat rates may be changed. In particular, paragraph 2.c. states:

> 2. The triggers for redetermination of the target heat rates are:
>
>   c. Additions, retirements or modifications to the generating systems or modifications to the generating system operating procedures, that are expected to increase or decrease the target heat rates by more than the deadband amount.

If the operation of DTCC1 and/or DTCC2 are changed, or if any other changes are made such that the target heat rates are increased or decreased by more than the deadband amount, Maui Electric proposes that any changes in operation be made at the time the target heat rate is actually changed

F. Findings and Conclusions

1. Overview

The Commission's Decision and Order No. 31288 in Docket No. 2011-0092 (Maui Electric 2012 Test Year Rate Case) stated that Maui Electric's System Improvement and Curtailment Reduction Plan should address the following topics:

(1) Plans and progress to date on implementation of recommendations to reduce or eliminate curtailment of renewable energy and lower total system costs, including but not limited to those recommendations and proposed investments evaluated in the Maui Energy Storage Study ("Sandia Study"), the Generation Performance & Reserve Study ("Cycling Study"), and the Hawaii Solar Integration Study ("HSIS");

(2) The elimination of must run designation and/or retirement of the units at KPP;

(3) Other options that Maui Electric may have identified to accept more renewable energy or otherwise lower total system costs, such as, for example, investments at independent power producer ("IPP") facilities to provide increased down reserve and other ancillary services or other strategies to reduce curtailment;

(4) Other load shifting incentives such as a very low dumped power rate offered to customers to shift customer demand to times when excess renewable energy would otherwise be curtailed;

(5) Utilization of demand response programs and energy storage technologies to reduce the need for on-line fossil generation to provide operating reserves and other ancillary services; and

(6) A comprehensive evaluation of all fixed and variable costs, as well as all system benefits (including fuel savings, O&M expense savings, system efficiency savings, etc.) estimated to result from curtailment reduction strategies underway or proposed in the System Improvement and Curtailment Reduction Plan. (D&O at 135-136)

Maui Electric's analyses described in Exhibit C and in this Exhibit L address the aforementioned Items (1), (2), (5) and (6). The evaluations performed for the aforementioned Items (3) and (4) are described in other exhibits.

The sections below summarize Maui Electric's findings and conclusions from its analyses on its previous actions and commitments (such as implementing the MOMs and lowering the minimum output ratings and K3 and K4) as well as on Items (1), (2), (5) and (6).

2. Effect of Implementing the MOMs

Implementing the MOMs results in a reduction in curtailment and a reduction in system costs. Please refer to the analysis in Section D.1 above.

3. Effect of Additional Curtailment Reduction Measures Already Implemented

Reducing the minimum output ratings of K3 and K4 and enabling these units to contribute to upward regulating reserve reduce curtailment substantially and reduce system costs slightly compared to implementing only the MOMs. Savings in fuel costs are largely offset by increases in payments to IPPs. The IPPs realize significant increases in revenue while ratepayers realize a small benefit from the reduction in total system costs. Please refer to the analysis in Section D.2 above.

4. Item (1) – Effect of Candidate Curtailment Reduction Measures from Completed Studies

a. Modification of Maalaea DTCC Operation

Generally, implementing projects to reduce the minimum output ratings on the DTCCs and/or enabling one-half of DTCC1 to cycle will produce the greatest curtailment reduction benefits while only minimally impacting total system costs.

1) Having only DTCC1 baseloaded with a lower minimum output rating in year 2016 results in the highest curtailment reduction benefit. Total system costs are only slight reduced compared to the Reference Case. Please refer to the analyses of Case 12 in Section D.14 above.

2) Case 19 results in the next highest curtailment reduction benefit. This is where M17 and M19 are cycled in simple cycle mode in years 2014 and 2015 for the months that M18 is not needed for capacity; DTCC1 is baseloaded; and DTCC1 is modified with lower minimum output rating in year 2016. Total system costs are reduced slightly more than in Case 12. Please refer to the analyses of Case 19 in Section D.21 above.

3) Case 11 results in the third highest curtailment reduction benefit. This is where only one-half of DTCC1 and DTCC2 are baseloaded and DTCC1 in single train mode is modified with a lower minimum output rating in year

2016. Total system costs are only slightly increased compared to the Reference Case. Please refer to the analyses of Case 11 in Section D.13 above.

4) Case 13 results in the fourth highest curtailment reduction benefit. This is where DTCC1 and one-half of DTCC2 are baseloaded and DTCC1 is modified with a lower minimum output rating starting year 2016. Please refer to the analyses of Case 13 in Section D.15 above.

b. Adoption of HSIS Regulating Reserve Policy

Implementing the HSIS regulating reserve policy in place of the existing WIS regulating reserve policy will reduce curtailment slightly and reduce costs slightly. Please refer to the analysis of Case 16 vs. Reference Case in Section D.18 above.

5. Item (2) – Elimination of Must-Run Designation and/or Retirement of the Units at KPP

a. Deactivation of K1 and K2

Deactivating K1 and K2 has minimal effect on curtailment and total system costs. Please refer to the analysis of Case 1 vs. the Reference Case in Section D.4 above.

b. Daily Cycling of K4

Reducing the operating hours of K4 to one shift during the peak period daily will slightly reduce curtailment but will significantly increase system costs. Please refer to the analysis of Case 4 vs. the Reference Case in Section D.7 above.

c. Retirement of KPP in 2019

Retirement of KPP in 2019 will require replacement generation to be put on the system. The type of generation installed will determine the effects on both cost and curtailment. The Reference plan utilizes a 17MW ICE unit with quick-starting capabilities. This allows a portion of that capacity to reduce the necessary upward regulating reserve carried by the Maui Electric units. This allows more as-available resources to be taken without running additional units and thereby reducing curtailment as seen in the difference between years before and after 2019. In Case 7 and Case 8 a 20MW/160MWh BESS is installed. This battery provides both capacity and voltage support for the Kahului area. The battery outputs 20MW during the period in which voltage support is needed. This will decrease the amount of as-available energy that can be taken.

6. Item (5) – Utilization of DR Programs and Energy Storage Technologies

   a. Implementation of Load Management and DR

Implementing load management and DR, as described in Exhibit H, would delay the need for additional generation but would increase system costs significantly without significantly reducing curtailment. Please refer to the analysis of Case 3 vs. the Reference Case in Section D.6 above. The Company will continue to explore different program designs, new technologies and the timing of implementation of the DR programs to determine what works best for the Company and its customers.

   b. Implementation of BESS, Load Management and DR

      1) Installing a BESS for capacity and/or regulating reserve is the costliest option and does not reduce curtailment. Please refer to the analyses of Cases 2, 7 and 8 in Section D.5, D.9, and D.10, respectively, above.

      2) Implementing DR, as described in Exhibit H, can actually increase costs and curtailment. Please refer to the analysis of Case 7 vs. Case 8 in Section D.10 above.

7. Item (6) – Comprehensive Evaluation of All Fixed and Variable Costs and System Benefits

   a. None of the candidate curtailment reduction measures substantially reduce system costs on a net present value basis over the 25-year planning period. In most of the cases where system costs are reduced, fuel savings are largely offset by either higher payments to IPPs or by capital costs.

   b. In many cases, Maui Electric's heat rates by fuel type will increase. Therefore, Maui Electric will need approval to reset its heat rate targets before the curtailment reduction measures are implemented or the heat rate deadband will need to be increased.

   c. Some cases with high curtailment reduction benefits will have higher reliability risks. For example, in Case 12, only three generators are baseloaded in the off-peak period (M14-15-16). On August 22, 2013, M15 and M16 both tripped off line with load shedding occurring. Further reliability analyses should be performed.

Risk Factors

Introduction

In this System Improvement and Curtailment Reduction Plan, Maui Electric has attempted to identify those actions, either already implemented, to be implemented, likely to be implemented and to be evaluated, to enable the Company to improve its system operations, reduce operating costs, increase the amount of renewable energy, and reduce the amount of wind energy curtailment. However, some action items are accompanied by certain operational risks and/or may be impacted by external forces beyond the Company's control. These risk factors are discussed below.

Adequacy of Supply

Maui Electric plans to retire the Kahului Power Plant ("KPP") by 2019. This will reduce Maui Electric-Maui Division's firm capacity by 37.6 MW-gross or 35.9 MW-net.

In 2019, the net system peak is projected to be 209.9 MW-net.[1] Maui Electric-Maui Division's total firm capacity as of December 31, 2012 was 262.3 MW-net.[2] Without the 16 MW currently provided by HC&S and the 35.9 MW-net currently provided by KPP, Maui Electric-Maui Division's total firm capacity would be reduced to 210.4 MW-net if no additional firm capacity is added. This amount of firm capacity would not be adequate to meet Maui Electric's capacity planning criteria for Maui.[3] Maui Electric would not have enough capacity to serve the projected peak demand if a unit is unavailable for maintenance and the largest unit is unexpectedly lost from service.

Please refer to Exhibit E for Maui Electric's portfolio approach to addressing the potential capacity shortfall.

System Stability

Currently, seven Maui Electric units (KPP Units K3 and K4, Maalaea Units M14, M15, M16, M17 or M19, and M18) are baseloaded and provide ancillary services (such as dispatchability, load following capability, frequency regulation and voltage regulation). After KPP is retired, Maui Electric may operate as few as three units during light loading periods (for example, in Case 18 as described in Exhibit C, page 26). Maui Electric will need to thoroughly study the stability of the system under various contingency situations (such as suddenly losing a large generating unit) with few units operating on the system before it can implement any one of the study cases. Maui Electric will need to understand the risks associated with operating with fewer units during light loading periods.

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[1] See Exhibit C, Attachment C2, page 8.
[2] See Maui Electric's Adequacy of Supply letter, filed on January 30, 2013 ("2013 AOS"), Attachment 2, page 1.
[3] Maui Division's capacity planning criteria are provided in Maui Electric's 2013 AOS, page 2, and in Exhibit C, Attachment C3 in this filing.

Voltage Support

As described in Exhibit E, KPP provides voltage support for the Kahului area. Once KPP is retired, alternative means for providing voltage support will need to be provided. These means include reconductoring the Waiinu-Kanaha 69 kV transmission line or installing a battery energy storage system ("BESS") with sufficient capacity and output duration. There are risks that the transmission line cannot be reconductored at all or in a timely manner (for example, see Exhibit G, page 5, for significant risks identified for the Waiinu-Kanaha Transmission Upgrade project scheduling or timing). There are also risks that a BESS cannot be installed by the time KPP is retired. If these projects cannot be installed in time, Maui Electric may not be able to provide sufficient voltage support in the Kahului area after KPP is retired.

Continued Low and Declining Sales Load

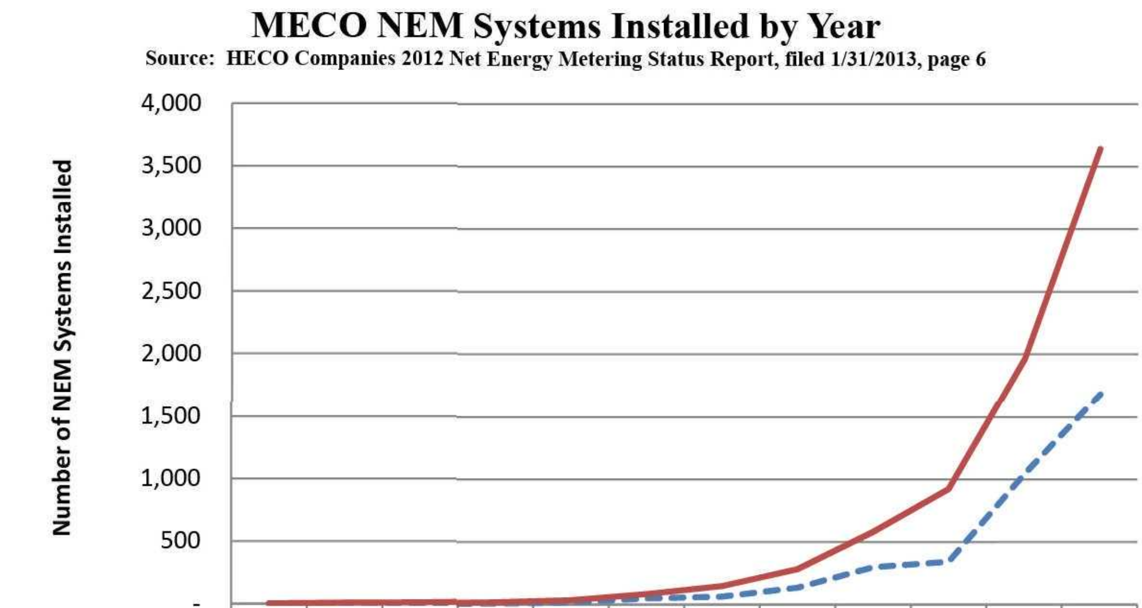
Despite all of Maui Electric's actions implemented and to be implemented which are described in this plan, declining sales will increase curtailment (all other things being equal) because the lower the demand there is on the system, the less opportunity there is for independent power producers ("IPPs") to sell their electricity. In the extreme case, envision the Maui demand growing to 4 or 5 times larger than today's demand. In that case, the minimum demand would be 425 MW, which is *greater than* all the nameplate capacity of the renewables on the Maui grid plus the minimum output of the baseloaded units. With such a demand, it is not hard to imagine that the time IPPs would be curtailed would be minimized. As it is today, the minimum is around 85 MW, which is *less than* the total combined nameplate capacity of the renewable generation on Maui. It is not hard to see that lower loads will necessitate additional curtailment.

Several factors contribute to low and declining sales such as the significantly higher penetration of customer-sited renewable generation and energy efficient technologies, customer conservation efforts driven by higher than projected energy prices, and slower than assumed recovery of the economy.

In 2012, Maui's residential and commercial sectors both experienced lower sales compared to 2011. The residential sector sustained the larger impact with sales decreasing by 5.4% as average monthly usage decreased by 6.3% compared to 2011. Commercial sales decreased by 1.9% compared to 2011. Higher energy prices coupled with federal and state incentives and utility tariffs such as net energy metering ("NEM"), standard interconnection agreements ("SIA"), and feed-in tariffs ("FIT") that support Hawaii's clean energy infrastructure led to higher penetrations of customer-sited renewable generation and energy efficient technologies which contributed to the lower year-over-year sales.

As reported in the 2012 Net Energy Metering Status Report filed January 31, 2013, page 6, the number of NEM installed systems on Maui Electric's grid jumped from 298 in 2009, to 342 in 2010, 1,039 in 2011, and 1,678 in 2012, a 463% increase over three years. Refer to Figure M1 below which shows the number of NEM systems installed by year.

Figure M1



	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012
Incremental	2	5	3	8	16	50	64	135	298	342	1,039	1,678
Cumulative	2	7	10	18	34	84	148	283	581	923	1,962	3,640

So far, 2013 shows no signs of slowing. Installations through June exceeded all previous years - over 850 systems have been installed, bringing the total to over 4,500 systems.

From a market demand perspective, customer-sited renewable generation installations are expected to continue to increase as customers seek lower cost energy alternatives. From a system reliability and stability perspective, the impact of NEM, SIA, and FIT installations over and above 100% of minimum day-time loads on circuits remains a concern. That concern is addressed by interconnection requirements studies which are increasingly being pursued by customers wanting to interconnect to the Maui grid. However, due to this system impact concern, an alternate customer-sited renewable generation scenario was developed to evaluate the impact of a lower number of interconnections on wind curtailment.

The alternate scenario was developed based on a market assessment in the near term which recognizes that there is already a dampening effect of the install ramp rate due to the existing circuit saturation. This resulted in reaching 100% of the daytime minimum load threshold at the end of 2016. Beyond 2016, projections developed in the Integrated Resource Planning ("IRP") process were utilized to project future load growth. In the IRP process, since the Hawaiian Electric Companies identified the "Stuck in the Middle" scenario as a reference case for various analyses, the load growth percentage in that scenario was used to represent future load growth. This load growth resulted in an average increase to the percent of daytime minimum threshold of about 1% a year or 1 MW/year. With the introduction of On-Bill Financing and Green Energy Market Securitization ("GEMS") expected in 2014, new financing mechanisms will be available to customers who previously did not have the ability to install customer-sited renewable energy systems. Customer interest in installing these systems remains high.

As shown in Figure M1 above, the growth of rooftop PV has soared since 2010. While a centralized commercial PV facility would likely be monitored and controlled by the utility, these distributed generation energy resources are not controllable by Maui Electric. Unless technological advances in the future enable utility control over these distributed resources, the Company cannot curtail these rooftop PV systems. As shown in Attachment D3, rooftop is likely to continue to drastically change the daytime load profile in the future, adversely affecting the amount of wind energy which could be accepted during the hours where these PV systems produce electric energy. Maui Electric remains committed to reviewing policies, programs and rules to improve the fairness and effectiveness in acquiring cost-effective clean energy for the benefit of all customers.

Impact of Environmental Compliance

The environmental impact due to modifications of existing firm generation resources are being reviewed by Maui Electric to determine if additional cost impacts will be required to implement the changes to the generating units. Also, environmental impacts are being reviewed to see if a change in minimum load operations and/or cycling of units will affect air permits and/or involve additional environmental requirements.

Impact to Existing Fuel Contracts for Industrial Fuel Oil ("IFO") and Diesel

It is anticipated the current fuel inter-island fuel supply contracts between Tesoro and the Hawaiian Electric Companies will be assigned to Par Petroleum Corp ("PAR") as a step transfer process in 2013. These contracts expire at the end of 2014 and any new contracts beyond 2014 await further progress on the ownership transfer of the Tesoro assets to PAR. Tesoro supplies IFO, ultra-low sulfur diesel ("ULSD"), and diesel to Maui Electric. Any new fuel contracts will affect the Chevron inter-island supply contract for IFO and diesel as all the fuel contracts are inter-twined. Any biofuel contracts will affect the amount of fossil fuel purchases with the new contracts starting in 2015.

Impact of Pending Proceedings before the Commission

There are pending proceedings before the Commission which could significantly change the economics of certain action items:

- *Proceeding to Investigate Whether an Oahu-Maui Interisland Transmission System May Be in the Public Interest*, Docket No. 2013-0169;
- *Proceeding to Review the Progress of Castle & Cooke Resorts, LLC's Proposed Lanai Wind Project*, Docket No. 2013-0168;
- Proceeding *Regarding Integrated Resource Planning*, Docket No. 2012-0036; and
- *Proceeding to Investigate the Implementation of On-Bill Financing*, Docket No. 2011-0186.

In addition, future Hawaii Gas liquefied natural gas ("LNG") related applications could impact the economics of certain action items. See page 12 of Hawaii Gas' application *For Approval (1) to commit funds in excess of $500,000 for the proposed SNG System Backup Enhancement Project, (2) of the Fuel Supply Agreement, (3) of the Fuel Delivery Contract, and (4) to include the costs of the Fuel Supply Agreement and the Fuel Delivery Contract in the Fuel Adjustment Clause of The Gas Company, LLC dba HAWAIIGAS*, Docket No. 2013-0184.